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Purpose: CERCLA Site Inspection Report

Site: Brown Vandever Abandoned Uranium/Vanadium Mine
(Part of Bluewater Uranium Mine)
Haystack Mountain-Ambrosia Lake Area
35°21'02" N-latitude; 107°56'25" W-longitude
Baca Chapter, Navajo Nation
Prewitt, McKinley County, New Mexico 87045

Site EPA ID Number: ~~NND983469891~~ NND986 669 117

U.S. EPA ERS Investigator: Robert Bornstein

NSP Investigators: Patrick Antonio
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Date of Inspection: November 13-16, 1990

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Navajo Superfund Program
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Report Date: March 30, 1992

FIT Review/Concurrence:

Submitted To: Paul La Courreye
EPA Region IX
Site Assessment Manager

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region 9, under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) has tasked the Navajo Superfund Program (NSP) to develop a Site Inspection (SI) Report for the Brown Vandever (BV) abandoned uranium/vanadium mine site in Haystack, McKinley County, New Mexico. The BV site has been combined with the adjacent Nanabah Vandever (NV) mine site but is evaluated separately in this report.

The BV mine site was identified as a potential hazardous waste site and entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) in March 1990. EPA was notified of the site by NSP. A Preliminary Assessment (PA) was performed by NSP in May 1990. The purpose of the PA was to review existing information on the site and its environs to assess the threat(s) posed to public health, welfare, or the environment and to determine if further investigation under CERCLA was warrented. EPA recommended further investigation of the BV site to more completely evaluate the site using EPA's Hazard Ranking System (HRS) criteria. The HRS assesses the relative threat associated with actual or potential releases of hazardous substances from the site. The HRS is the primary method of determining eligibility for placement on EPA's National Priorities List (NPL). The NPL identifies sites at which EPA may conduct remedial response actions. Subsequent response action (reclamation) was directed by the EPA Region 9 Emergency Response Section (ERS) due to the imminent hazards posed by the site. This SI Report is the result of a joint investigation performed by ERS and NSP.

1.1 Apparent Problem.

Prior to ERS reclamation on the BV site, there was documented soil contamination with a potential for air migration [1]. The sources of contamination were unreclaimed radioactive mine tailings and mine workings (open pit and declines) [2]. High gamma radiation levels also signified soil contamination. (A desciption of the contamination and potential sources is in Section 4.1.) The unreclamated radioactive mine tailings apparently had migrated via surface runoff and by wind. The BV site and most of the NV site were recently reclamated under ERS supervision. Subsequently, the risks at the reclamated areas have been diminished [3].

In 1988, the Bureau of Land Management (BLM) informed Navajo EPA of the many unreclaimed Haystack area mines and of a potential radon threat to the Navajo residents located near the mines [4]. (NSP is within Navajo EPA.) EPA review of NSP's PA for the BV site led to a recommendation of an SI. Due to health risks from the

the presence of radioactive mine tailings, physical hazards, and potential for heavy metal contamination, on November 15-16, 1990, EPA Region 9 ERS performed a geochemical and georadiological study of the BV-NV sites to assess the environmental and physical hazards of the sites [1]. Elevated concentrations of radioactive isotopes were detected in on-site soils [1]. Soil samples did not reveal any significant heavy metal contamination [1]. A more thorough gamma survey was conducted on August 11-19, 1991 by the ERS. Within the BV-NV sites, waist level and ground contact level gamma radiation readings were significant [1]. Detailed analytical results are in Section 3.0.

2.0 SITE DESCRIPTION

2.1 Site Location.

The BV site consists of abandoned uranium/vanadium mines in eastern McKinley County, NM (SW1/4, SW1/4, Sec.18 and N1/2, NW1/4, Sec.19 of T13N, R10W, NM Meridian; Lat.: 35°21'02" N, Long.: 107°56'25" W)[5]. The site is adjacent to Haystack Butte, on grazing land 4 miles east of Prewitt, NM [Fig.1]. The BV PA assessed both the 1/4 section BV claim, in Sec.18, with an adjacent 1/4 section mine claim called the Haystack Section 19 Open-pit Complex (HS)[6]. The BV site, the adjacent Nanabah Vandever site, and the nearby Desiderio Group mines comprise the Bluewater Uranium Mine site (NND983469891) which received ERS reclamation. The BV claim is on Indian Allotment land where the Department of Interior's (DOI) Bureau of Indian Affairs (BIA) has pervasive power over the land, and the Navajo Tribe has no consent privileges. Whereas, the HS claim is on private land where leases are controlled by the State.

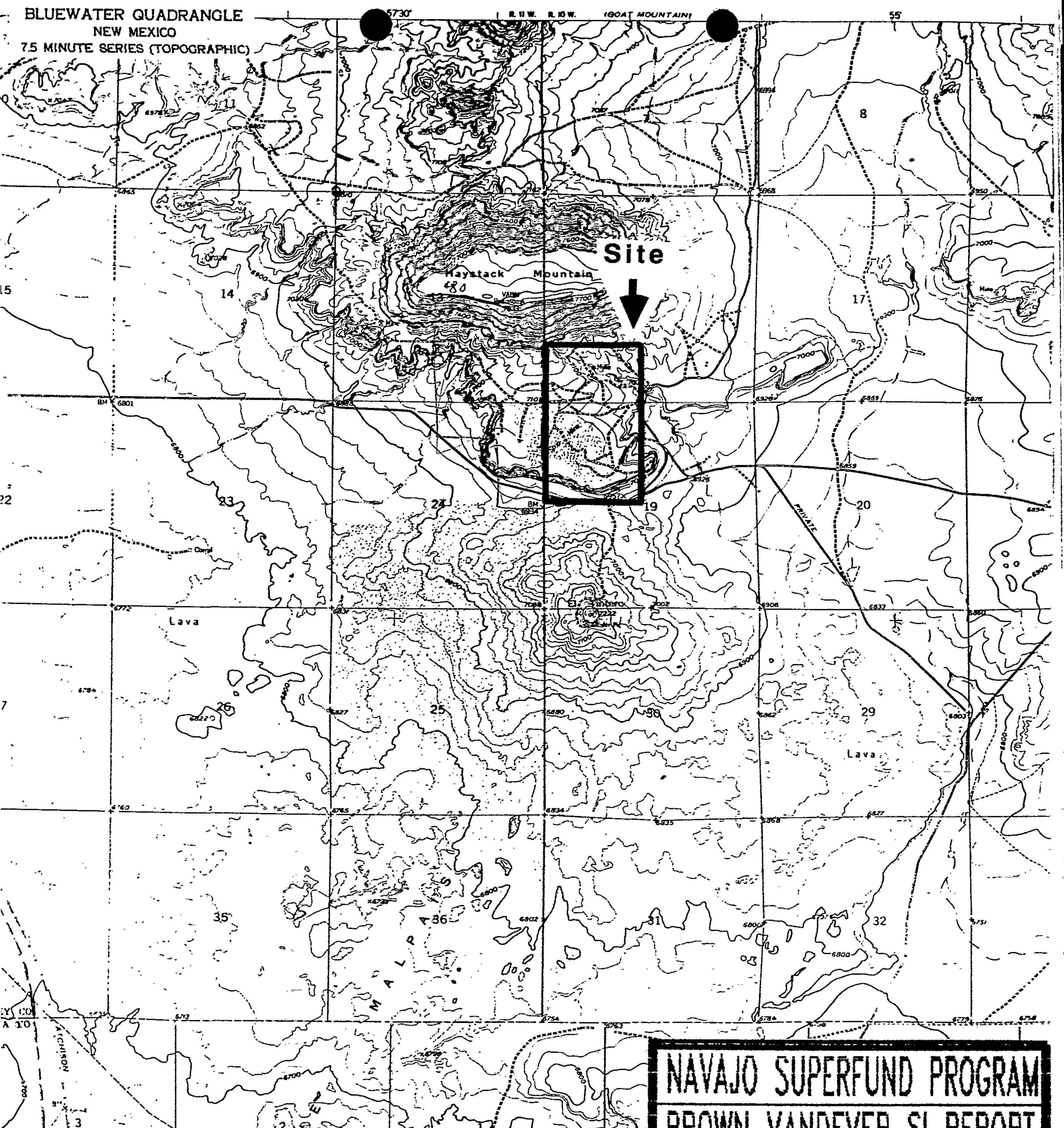
2.2 Site Description.

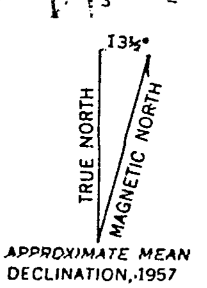
In pre-reclamation conditions, the BV claim consisted of 2 declines and about 21,100 cubic yards (yd^3) of mine tailings material and the HS claim consisted of a strip mine complex with about 511,100 yd^3 of tailings material [2; Fig.2; Fig.3]. Post-reclamation conditions have the declines and strip mine filled and the tailings covered, recontoured and reseeded [1]. Residents are adjacent to the reclamated mine workings. An abandoned mine office remains on the BV claim. See Appendix A for Photodocumentation of the BV site.

2.3 Operational History.

The BV claim operated through Tribal leases administered by the BIA [2]. Operators and operation periods included: Sutton, Thompson, and Williams (1952); Williams (1953); Santa Fe Uranium (1955); Santa Fe Uranium and Federal Uranium (1955-56); Federal Uranium (1957-59); Mesa Mining Co. (1963-64); and, Cibola Mining Co. (1966)[6]. Operations ceased in 1966 and the BV property relinquished to the allotment owner. The HS mineral rights have been owned by a Santa Fe Pacific Properties, Inc. (SFPR) subsidary [1]. The HS claim produced ore intermittently during 1952-81 via State mining leases and SFPR contracts to the Haystack Mountain Development Co., Henri T. Dole, George Warnock, and the Todilto Exploration and Development Corp. [1]. In mid-1980, HS mineral rights were transferred to the Cerrillos Land Co. (CLC), a SFPR company [1].

The uranium ore mined was predominantly calcium carnotite in the host Todilto Limestone [1]. Operations involved underground mining techniques (2 declines) for deeper ore deposits on the BV claim and





1 mi. = 1-11/16 in.

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Fig.1 Location Map

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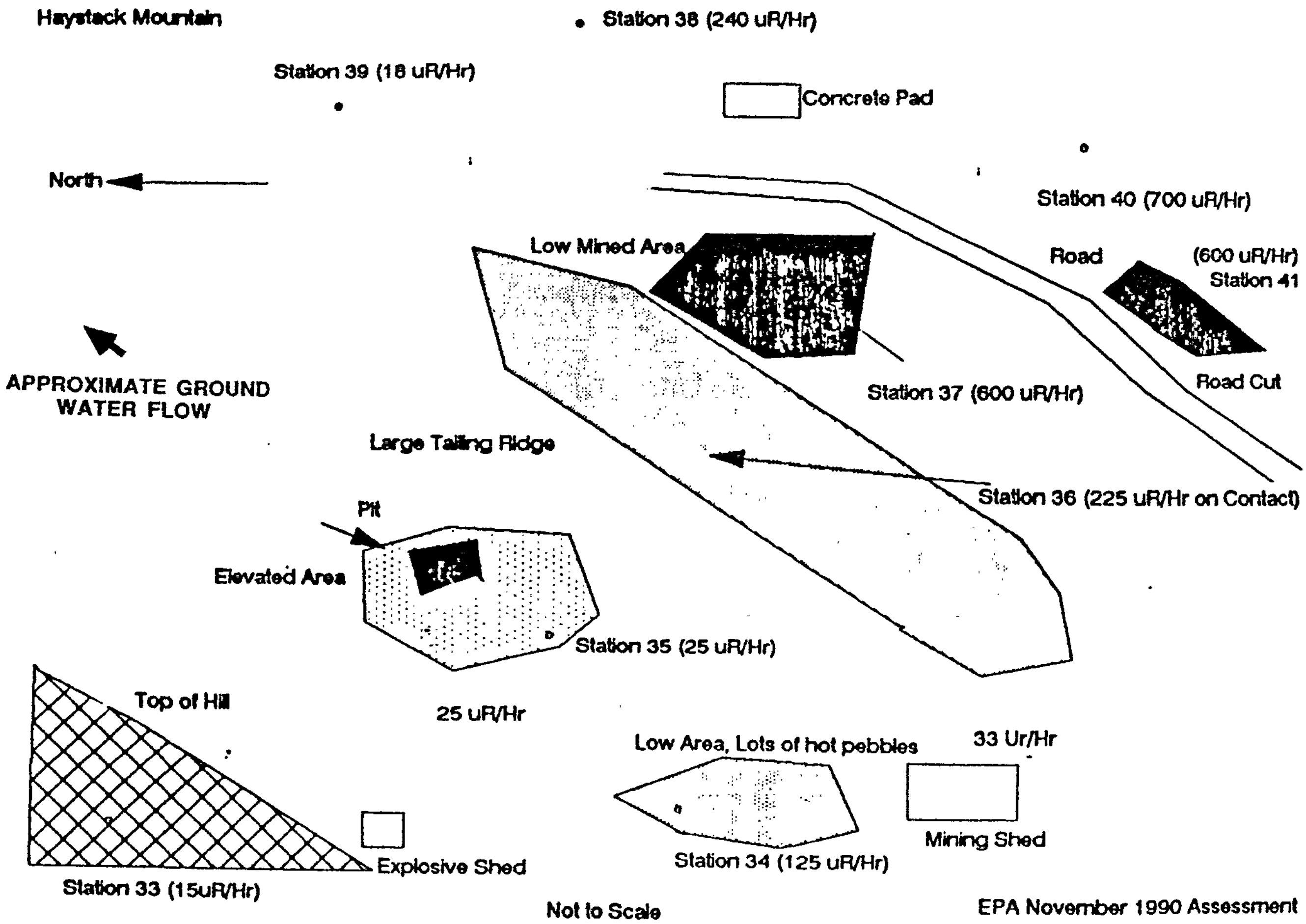
SAMPLING STATIONS, BROWN-VANDEVER MINE SITE SECTION 4



SAMPLING SECTION LOCATIONS, BROWN-VANDEVER MINE SITE

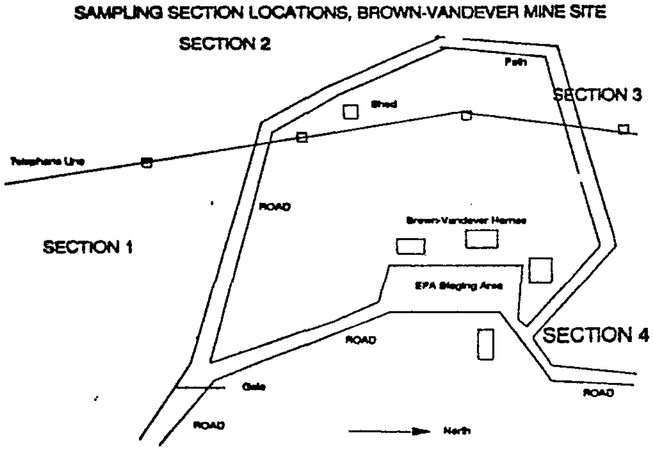


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Fig.2 BV Claim Site Sketch and Sample Locations
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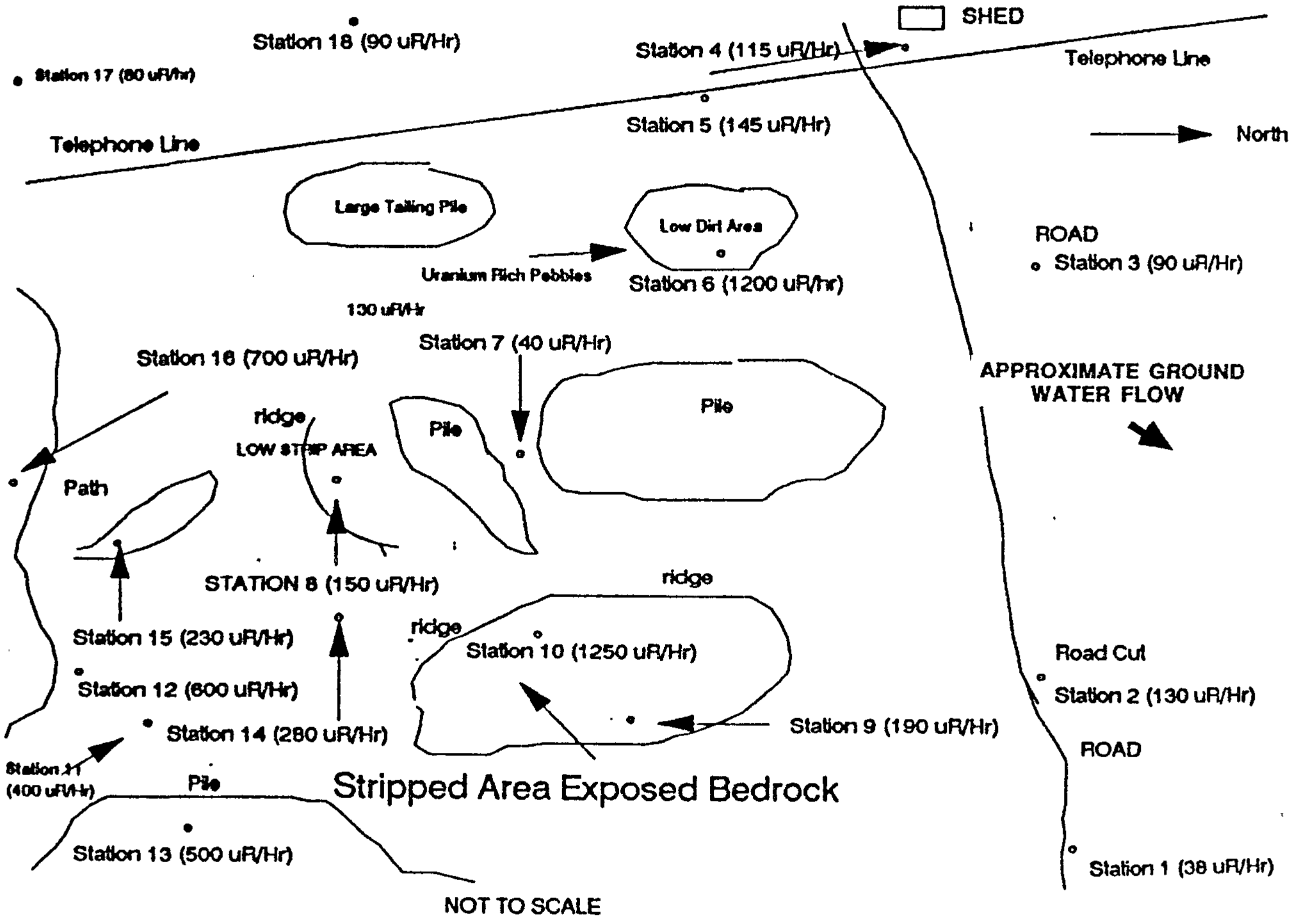
SAMPLE LOCATIONS, BROWN-VANDEVER MINE SITE SECTION 1



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SAMPLING SECTION LOCATIONS, BROWN-VANDEVER MINE SITE

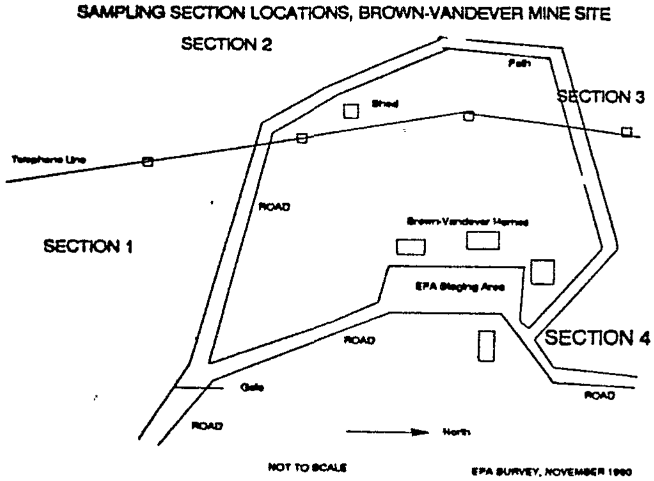

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Fig. 3 HS Claim Site Sketch
and Sample Locations

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strip mining for shallower ore deposits on the HS claim [2]. Overburden was blasted, removed and put in large piles. Ore failing to contain significant quantities of uranium was disgarded on-site [2]. Higher-grade ore was shipped off-site to processing mills. No formal reclamation program was instituted after mining ceased, so mine workings and tailings were left intact with no prevention of physical, chemical or radiological hazards.

The BV claim produced 25,796 tons of ore yielding 98,175 lbs of U_3O_8 (0.19%) and 75,342 lbs of V_2O_5 (0.16 %) [6]. The HS claim produced a total of 137,310 tons of ore yielding 562,267 lbs of U_3O_8 (0.20%) and 165,494 lbs of V_2O_5 [6].

2.4 Regulatory Involvement.

NSP through a site assessment cooperative agreement with EPA conducted a PA for the BV site. Following review of the BV PA, EPA recommended the site for SI. The Agency for Toxic Substances and Disease Registry (ATSDR) issued a health advisory on November 21, 1990 for the Bluewater Uranium Mine site based on the presence of uranium-containing radioactive mine wastes, areas potentially contaminated with heavy metals, and many physical hazards [7]. ERS was notified by ATSDR on the potential hazards and proceeded to collect site data and, ultimately, oversaw reclamation on most of the BV-NV sites. [Only Sec. 13 on the NV site was not reclamated because it is under the jurisdiction of the Department of Energy].

Since leasing of the BV claim was managed through the BIA (DOI) and leasing for the HS claim was overseen by the State of New Mexico, EPA and NSP met various times with, or contacted, the following parties in an attempt to workout an agreement on needed cleanup:

For the BV Claim:	DOI Administration
	Office of Surface Mining (within DOI)
	BIA (within DOI)
	BLM (within DOI)
	Navajo Abandoned Mine Lands
	New Mexico Abandoned Mine Lambs
	Indian Health Service (IHS)
For the HS Claim:	SFPR/CLC
	Private Landowners
	New Mexico Environmental Improvement Div.

EPA carried out response actions on the BV claim hoping that identified potential responsible parties (BIA/DOE) would finance, wholly or partially, the cleanup efforts. Presently, this has yet to transpire. SFPR/CLC successfully carried out reclamation on the HS claim [8]. EPA and SFPR reclamation activities involved filling mine workings, placing down contoured cover, and reseeding.

3.0 INVESTIGATIVE ACTIVITIES

3.1 Previous Sampling.

No previous sampling has apparently occurred. NSP obtained elevated gamma radiation levels at downwind and downgradient areas of the site during the PA investigation and pre-response action period.

3.2 EPA Sampling.

On November 15-16, 1990, ERS collected pre-reclamation environmental samples from the Bluewater Uranium Mines. In the post-reclamation week of September 15, 1991, ERS collected 2 composite soil samples (for analysis of uranium isotopes and Radium 226) from the soil cover in the BV claim, not the HS claim.

3.2.1 Purpose and Description of Sampling Event. The purpose of EPA's pre-reclamation sampling event was to collect soil, air, surface water and groundwater samples for analysis of heavy metals and radioactivity to characterize the amount and extent of contamination associated with the mine tailings and to assess the health impacts associated with the tailings due to environmental and physical hazards [1]. ERS performed the geochemical and georadiological study of the Bluewater Uranium Mines sites.

Sampling occurred as indicated in ERS's Preliminary Assessment Workplan dated November 9, 1990 [9]. For the BV site, the workplan called for: an initial gamma radiation survey to determine external radiation hazards associated with the site; collection of soil samples from tailings and downdrainage areas; collection of on-site surface water samples, if present; and, collection of groundwater from area wells and nearby house taps [9]. The soil and water samples were analyzed for radioactivity (uranium and radium isotopes) and heavy metal concentrations [10]. Figures 2 and 3 depict sample locations. Table 3-1 has sample location rationale.

3.2.2 Deviation from Sampling Plan. Due to the lack of on-site surface water, no surface water samples were collected. Instead, more groundwater samples were obtained than originally planned.

3.2.3 Discussion of Sample Results. The BV site pre-reclamation analytical results indicate: soil samples 5A, 6A, 7A and 21A, within the mined areas, exceeded the promulgated standard for Radium-226; soil samples did not reveal any significant amount of heavy metal contamination; and, there was no evidence that the groundwater has been affected by hazardous substances at the site [10]. The initial groundwater sample (Sample #W7) from the Pre-school well (livestock use) indicated highly elevated radionuclide levels, apparent due to lab/sampling error [10]. A re-sample (Sample #W8) of the Pre-school well by the IHS indicated low

Table 3-1
SAMPLE LOCATION AND RATIONALE

Sample Type	Sample #	Location	Rationale
Tailings	5A	Station 6 HSC Pebble Area	Constituent Concentration of Source Material
Tailings	6A	Station 10 HSC Strip Area	" "
Tailings	7A	Station 11 HSC Claim	" "
Soil	8A	Wash Area Near BV BV Claim	Off-site Contaminant Transport Downstream
Tailings	21A	Station 40 BV Claim	Constituent Concentration of Source Material
Soil	9A	Road to BV	Background Concentration
Groundwater	W1	Well 16T-522	" "
Groundwater	W1D	" "	Duplicate (QA/QC)
Groundwater	W1S	" "	Spike (QA/QC)
Groundwater	W1SD	" "	Spike Duplicate (QA/QC)
Groundwater	W2	Well 16T-551	Off-site Contaminant Transport Downgradient
Groundwater	W3	B. Vandever Tap	" "
Groundwater	W4	PWS Waterline	" "
Groundwater	W7	Preschool Well	" "
Groundwater	W8	" "	Re-Sample of W7

NOTE: QA/QC samples for soil samples were obtained on the Na-nah-bah Vandever (NV) mine site, and are included in the Reference No. 10.

radium levels, but gross alpha was just over the MCL [11]. IHS requested re-painting the "LIVESTOCK USE ONLY" sign on the well's water storage tank [11]. Table 3-2 has results of the metals analysis. Table 3-3 has results of the radionuclides analysis. Reference No. 10 contains all lab analytical documentation.

The two BV site post-reclamation soil samples were obtained from cover material and a random background locale. The soil sampling data (Total Uranium and Radium 226) revealed the reclamation successfully reduced any potential surface radiological hazard [3]. No sample exceeded the regulatory standard of 5 picoCuries per gram (pCi/g) over background pursuant to 40 CFR Section 192 [3]. Results of the BV site post-reclamation soil sampling analysis are as follows:

Sample ID	Total Uranium	Radium 226
BV18A	1.5 pCi/g	0.94 pCi/g
BV18B (bkgrd)	0.97 pCi/g	0.93 pCi/g

Overall, the pre-reclamation sampling analytical results revealed that contamination on the BV-NV sites was primarily confined to on-site soil radiation (Radium-226), especially in disturbed mine areas [1]. (A documented measurement of high radon-flux off tailings material was obtained prior to ERS response from the Desiderio Group mines.) However, post-reclamation sampling analytical results indicated both gamma radiation and radionuclide concentrations at the BV site have been reduced to "natural" or background conditions [3].

Table 3-2. Results of Metals Analyses

Sample No. and Location	Elements (Benchmarks in parenthesis) Al	As	Ba	Cr	Pb	Mg
			Soil Samples in mg/kg			
	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
5A Station 6 (HSC Pebble Area)	4210	0.8	196	ND	9.2	1800
6A Station 10 (HSC Strip Area)	3640	0.8	79	ND	8.3	2000
7A Station 11 (HSC Claim)	4320	1.7	200	ND	26.6	2580
8A Wash Area Near BV (BV Claim)	2970	1.4	58.5	ND	21.9	1154
21A Station 40 (BV Claim)	3320	6.0	65.0	ND	23.1	1930
9A Road to BV (BKGRD)	3060	0.8	4930	ND	3.9	1480
			Water Samples in mg/L			
	(N/A)	(0.05)	(1.0)	(0.05)	(0.05)	(N/A)
W1 Well #16T-522 (Livestock Use)	ND	0.003	ND	ND	0.002	11.7
W2 Well #16T-551 (PWS Well)	0.042	ND	ND	ND	0.013	2.08
W3 B. Vandever Tap	ND	ND	0.03	ND	ND	1.76
W4 PWS Waterline	ND	ND	0.03	ND	ND	ND
W7 Preschool Well (Livestock Use)	1.06	ND	ND	ND	0.006	1.61

N/A: Benchmark not available.
ND: Not detectable.

Table 3-2. Continued

Sample No. and Location	Mn	Mo	Se	Sr	Ti	V
	Elements (Benchmarks in Parenthesis)					
	Soil Samples in mg/kg					
	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)	(N/A)
5A Station 6	226	ND	<0.2	182	52.8	186
6A Station 10	229	ND	<0.2	154	40.0	185
7A Station 11	273	ND	<0.2	15.3	15.9	847
8A Wash Area Near BV	105	ND	<0.2	25.5	25.3	9.63
21A Station 40	225	ND	1.4	22.6	22.5	1410
9A Road to BV (BKGRD)	2580	ND	<0.2	35.1	25.1	6.07
	Water Samples in ug/L					
	(0.05)	(0.1)[a]	(0.01)	(N/A)	(N/A)	(N/A)
W1 Well #16T-522	0.103	0.052	<0.002	11.2	ND	ND
W2 Well #16T-551	ND	ND	ND	ND	ND	ND
W3 BV Tap	ND	ND	ND	0.12	ND	ND
W4 PWS Waterline	ND	ND	ND	2.55	ND	ND
W7 Presch. Well	0.02	ND	ND	0.12	ND	0.22

N/A: Benchmark not available.
ND: Not detectable.
a: Benchmark from 40 CFR 192.02(a)(3) Table 1

Table 3-3. Results of Radiometric Analyses

Sample No. and Location	U-233/234	U-235	U-238	Ra-226	Ra-228
			Isotopes (Benchmarks in Parenthesis)		
			Soil Samples in pCi/g		
	(N/A)	(N/A)	(N/A)	(5.0)[b]	(N/A)
5A Station 6 (HSC Pebble Area)	24.0	1.0	25.0	49.0	0.0
6A Station 10 (HSC Strip Area)	100.0	4.7	100.0	130.0	0.0
7A Station 11 (HSC Claim)	290.0	20.0	310.0	260.0	1.0
8A Wash Area Near BV (BV Claim)	1.1	00.0	1.1	1.9	1.0
21A Station 40 (BV Claim)	330.0	29.0	390.0	450.0	1.0
9A Road to BV (BKGRD)	0.6	13.0	000.7	00.8	0.0
			Water Samples in pCi/L		
	(U-234/238 = 30)			(Ra-226/228 = 5.0)	
W1 Well #16T-522 BKGRD?? (Livestock Use)	2.0	00.3	0.4	00.8	2.0
W2 Well #16T-551 (PWS Well)	0.5	00.0	0.0	00.2	0.0
W3 BV Tap	2.1	1.0	0.8	00.2	0.0
W4 PWS Waterline Up Dip I.G.	1.4	0.5	0.5	0.1	0.0
W7 Preschool Well (Livestock Use)	130.0	3.0	74.0	1.0	22.0
		Gross Alpha			
		(15.0)			
W8 Re-Sample of W7		15.5		0.0	0.0

N/A: Benchmark not available.
b: In top 15 cm.

4.0 HRS FACTORS

The HRS is a scoring system used to assess the relative threat associated with actual or potential releases of hazardous substances from sites. It is the principal mechanism EPA uses to place sites on the NPL. NSP has evaluated the following HRS factors relative to the BV site, although the BV site was assessed (scored) together with the NV site.

4.1 Sources of Contamination

Prior to reclamation, the two BV claim declines, HS claim open-pit complex, and associated mine tailings were sources of contamination [2]. The tailings material was suspected of generating leachate composed of radiometric species which migrated with surface runoff [2]. Radioactive particulates were being blown off the tailings piles [2]. The estimated total volume of tailings on the BV site was 532,222 yd^3 (21,111 yd^3 BV Claim and 511,111 yd^3 HS claim) [2]. The two BV claim declines (200-ft inclined shafts) potentially emitted significant radon gas levels [2]. EPA and SFRP reclamations have negated the sources of contamination [3,8].

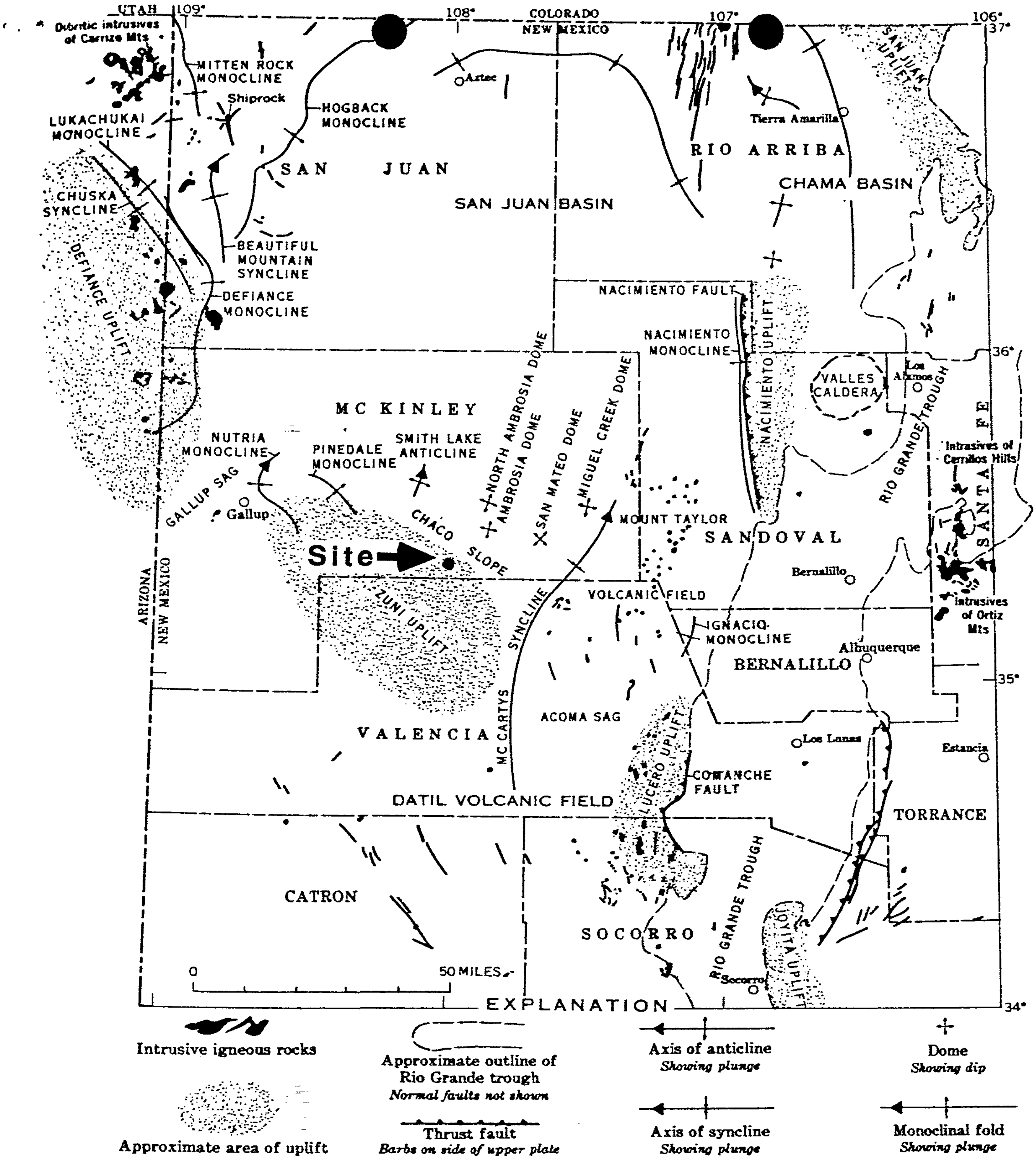
4.2 Groundwater Pathway

4.2.1 Hydrogeologic Setting. Regionally, the site is on the southern Chaco Slope within the Colorado Plateau physiographic province [12]. The site is bounded on the north by the San Juan Basin and on the south by the Zuni Uplift [12; Fig.4]. Area stratigraphy consists of several thousand feet of consolidated sedimentary rocks sloping 3-10^{o} N-NE into the San Juan Basin, with associated intrusive and extrusive rocks of the Mt. Taylor volcanic field [12].

The site is on the Todilto Limestone (LS) composed of very fine-to medium-grained LS with some shale and sandstone (SS) [12]. Mineable ore reserves were in the Todilto LS [6]. Subsequent descending strata are the Entrada SS, the Chinle Formation with the basal Shinarump Conglomerate, and the San Andres LS/Glorieta SS [12]. Developed area aquifers are the Entrada SS, the Sonsela SS of the Chinle Formation, and the San Andres LS/Glorieta SS [13]. Groundwater on-site is estimated at 140 feet below surface, derived by projecting updip from a nearby well. Aquifers are recharged by infiltration at outcrops south of the site. Area groundwater flows in a N-NE direction, corresponding to the dip of bedrock [2].

Additionally, mine declines and exploratory drillholes descended possibly to depths of 200 feet [2].

4.2.2 Groundwater Targets. The nearest public water supply (PWS) well (#16T-551) is located downgradient 1 mile SE of the site in the Sonsela aquifer and serves about 430 people [13]. The PWS



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BROWN VANDEVER SI REPORT

Fig. 4 Regional Geology

P. ANTONIO MARCH'92

After Ref. 12

well has a static water level of 417 feet below surface [13]. There are 4 other wells, all used for livestock, within 1.5 miles of the BV site [13]. There is a possibility of human cosumption of water from the livestock wells due to lack of PWS availabiity [2]. Only one livestock well (Pre-school) has been shown to be above drinking water standards [11].

4.2.3 Groundwater Pathway Conclusion. Four out of the 5 wells near the BV site show no contamination [10]. The Pre-school well has a gross alpha level just above the MCL; however, it is difficult to attribute the increased gross alpha level to the BV site. This also indicates the declines and exploratory drillholes are not or are inefficient conduits for groundwater contaminant migration, predominantly due to poor conductivity of the Todilto LS. With this in mind, there is apparently very little potential for contaminant migration from the BV site to area groundwater.

4.3 Surface Water Pathway

4.3.1 Hydrologic Setting. BV on-site runoff flows eastward in minor drainages before all reach a confluence in an ephemeral stream within 0.5 miles SE of the site [5]. Within 5 miles of the site, the ephemeral stream terminates into the surrounding valley floor [5]. The BV site physical soil profile consists of light colored soils dominated by Torriorthents and Haplargids groups with rock outcrops [14]. These soils are dry/salty and are principally derived from SS, shale and LS [14]. Such soils are present on gently sloping and undulating landscapes, also on steeply sloping and rolling ridges [14]. The texture of this soil category ranges from sandy loam to heavy clay loam [14]. Soil depth is 0-40 inches [14]. The 2-year, 24-hour rainfall in the site vicinity is 1.2-1.4 inches [2]. The net precipitation for the site is estimated to be minus 44 inches [2]. The site is not in a 100-year floodplain but the area is prone to severe thunderstorms and flash flooding is known to occur [2].

4.3.2 Surface Water Targets. There are no drinking-water intakes, irrigation, industrial, or recreational uses of surface water within the entire 5-mile drainage length [2,5]. Area livestock are known to drink accumulated surface water in earthen stock ponds located throughout the drainage length [2]. There apparently is no critical habitat for federally designated threatened or endangered species within the downdrainage area of concern [2].

4.3.3 Surface Water Pathway Conclusion. The only significant target involves livestock consumption of ponded surface water. The analytical results of a downdrainage soil sample indicates very little contaminant transport [10]. The covering of the source material makes the anticipated potential for human exposure via this pathway very low.

4.4 Soil Exposure and Air Pathways

4.4.1 Physical Conditions. Pre-reclamation conditions had the BV site readily accessible with no recreational use, sparse vegetation of native grasses and shrubs, roads present through and around the site, open mine workings [2]. Approximately 87 acres of the BV site required reclamation due to surface contamination [1]. Sources of the contamination were 2 open declines, used as trash dumps, an open-pit complex, and a substantial amount of mine tailings [2]. Elevated concentrations of radium and uranium detected in on-site soils, waist level radiation levels ranged from 20-750 micro-Roentgens per hour (uR/hr), and significant radon-flux emissions were attributed to these sources [1]. Background radiation was determined to be about 11 uR/hr [1]. There was also a good potential for the transport of radioactive particulates because of the fine-grained nature of the tailings material, the lack of containment, and the semi-arid, windy climate of the region [2].

Post-reclamation conditions have the BV site still accessible but with posted warning signs, revegatated with native grasses, and all roads reclaimed [1]. The 3-4 foot cover placed on the reclamated areas reduced radiation to below applicable radiological standards [3].

4.4.2 Soil and Air Targets. The on-site population consists of about 3-10 workers comprised of sheepherders [2]. There are also more than 40 people living within 0.25 miles of the site and some 630 people residing within 4 miles of the site [1,2]. Children often play on-site [2]. Livestock are known to graze throughout the site [2]. There are no threatened or endangered species known to be habitating areas that were contaminated [2].

4.4.3 Soil Exposure and Air Pathways Conclusions. The reclamated cover has apparently sharply lowered the potential for exposure via these particular pathways.

5.0 EMERGENCY RESPONSE CONSIDERATIONS

The National Contingency Plan [40 Code of the Federal Register 300.415(c)(2)] authorizes the Environmental Protection Agency (EPA) to consider emergency response actions at those sites which pose an imminent threat to human health or the environment.

In pre-reclamation conditions, emergency response by EPA Region 9 was deemed appropriate at the BV site for the following reasons: the site was readily accessible and uncontained, allowing the following hazards to exist; the open pits and declines posed a significant physical hazard to the neighboring populations; any heavy metals associated with the weathering mine tailings seemed to pose a significant environmental and health hazard; and, elevated concentrations of radioactive material within the tailing piles were likely migrating and may have exposed the neighboring population to unsafe levels of radiation [1].

There is no apparent need for emergency response for the BV site at this time because the reclamation action undertaken by EPA and SFRP has significantly reduced the radiological hazards associated with gamma radiation and radionuclide concentrations [3]. ATSDR has indicated that removal actions were satisfactory and protective of public health [1].

6.0 SUMMARY

The Brown Vandever abandoned uranium/vanadium mines site is 4 miles east of Prewitt, New Mexico in eastern McKinley County, next to the Haystack Butte (SW1/4, NE1/4, Sec. 18 and NW1/4, SE1/4, Sec. 19 of Township 13 N, Range 10 W, NM Meridian). Section 18 contains the BV claim and Section 19 contains the Haystack Open-pit Complex. The BV claim was operated intermittently during 1952-66 by various op-perators. The Haystack Open-pit Complex was operated intermittently during 1952-81, with mineral rights held by Santa Fe Pacific Properties, Inc. No formal reclamation program was instituted after mining ceased.

Over the operational history of the BV site, ore with insufficient quantities was abandoned on-site. An estimated total volume of 532,222 cubic yards of mine tailings material was left uncontained on-site. The mine tailings material was a radiological hazard due to elevated emissions of gamma radiation levels, radium, and radon-flux. Mine tailings material was suspected of being carried off by surface runoff. Particulate matter was being blown off the mine tailings piles. Recent EPA reclamation on the BV site has diminished the risks associated with the mine tailings contamination.

The Brown Vandever mines site was combined and scored under the Hazard Ranking System with the adjacent Na-nah-bah Vandever mines site. The following are significant Hazard Ranking System factors associated the Brown Vandever mines site after recent EPA reclamation, excluding the Na-nah-bah Vandever mines site:

- Low potential for a documented release to groundwater, attributable to the site;
- Low potential for a documented release to surface water, air, and soil;
- About 40 people reside within 0.25 miles of the site and 3-10 people herd sheep on-site; and,
- Recent EPA reclamation has negated both an observed release to soil and a high waste quantity.

The Navajo Superfund Program was the predominant tribal office involved with this site. An environmental health workshop is being planned by the Navajo Superfund Program for the Haystack area residents. The EPA recently performed reclamation on this site, and will be addressing the reclamation of a portion of the adjacent Na-nah-bah Vandever mines site that is under the control of the Department of Energy.

7.0 EPA RECOMMENDATIONS

U.S. EPA

	Initial	Date
No Further Remedial Action Planned Under CERCLA	PRL	12.10.92
Higher-Priority LSI under CERCLA		
Lower-Priority LSI under CERCLA		
Defer to Other Authority (e.g., RCRA, TSCA, NRC)		

Site is well stabilized due to EPA Emergency Response actions.

8.0 REFERENCES

1. U.S. EPA, "Federal On-Scene-Coordinator's Report: Bluewater Uranium Mine Sites," prepared by Robert Bornstein, Region 9, October 29, 1991.

2. Navajo Superfund Program, "Preliminary Assessment of Brown Vandever Uranium Mine," prepared by Patrick Molloy, May 20, 1990.

3. Bornstein, Robert, U.S. EPA ERS, Region 9, to Bluewater Interagency Committee, memorandum re: post removal soil data for Bluewater Uranium Mine Sites, December 23, 1991.

4. Hanks, Herrick E., Bureau of Land Management, Rio Puerco Resources Area, to Louise Linkin, Navajo EPA, letter re: radon gas in Navajo homes, July 7, 1988.

5. U.S. Geological Survey, map of Bluewater, New Mexico, 7.5 Quadrangle, 1957.

6. McLemore, Virginia T., Uranium and Thorium Occurrences in New Mexico: Distribution, Geology, Production, and Resources, with Selected Bibliography, New Mexico Bureau of Mines and Mineral Resources, Open-file Report 183, September 1983.

7. Agency for Toxic Substances and Disease Registry, "Public Health Advisory: Navajo-Brown Vandever and Navajo-Desiderio Uranium Mining Areas, Navajo Nation, Bluewater, New Mexico," November 21, 1990.

8. Eby, Paul G., Cerrillos Land Company, to Robert Bornstein, U.S. EPA Region 9 ERS, letter re: post response report-EPA Order 91-16, November 27, 1991.

9. U.S. EPA, "Preliminary Assessment Workplan: Navajo-Brown Vandever and Navajo-Desiderio Uranium Mining Areas, Navajo Nation, Bluewater, New Mexico," prepared by Robert Bornstein, Region 9, November 9, 1990.

10. Bornstein, Robert, U.S. EPA ERS, Region 9, to Gaurav Rajen, Navajo Superfund Program, letter re: Bluewater Uranium Mine preliminary assessment data, January 29, 1991.

11. Dowell, Charles, Indian Health Service, Navajo Area, to Rosita Loretta, Baca Chapter House, letter re: pre-school well water sample data, May 9, 1991.

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12. Hilpert, Lowell, Uranium Resources of Northwestern New Mexico, U.S. Geological Survey, Professional Paper 603, Washington, D.C.: GPO, 1969.

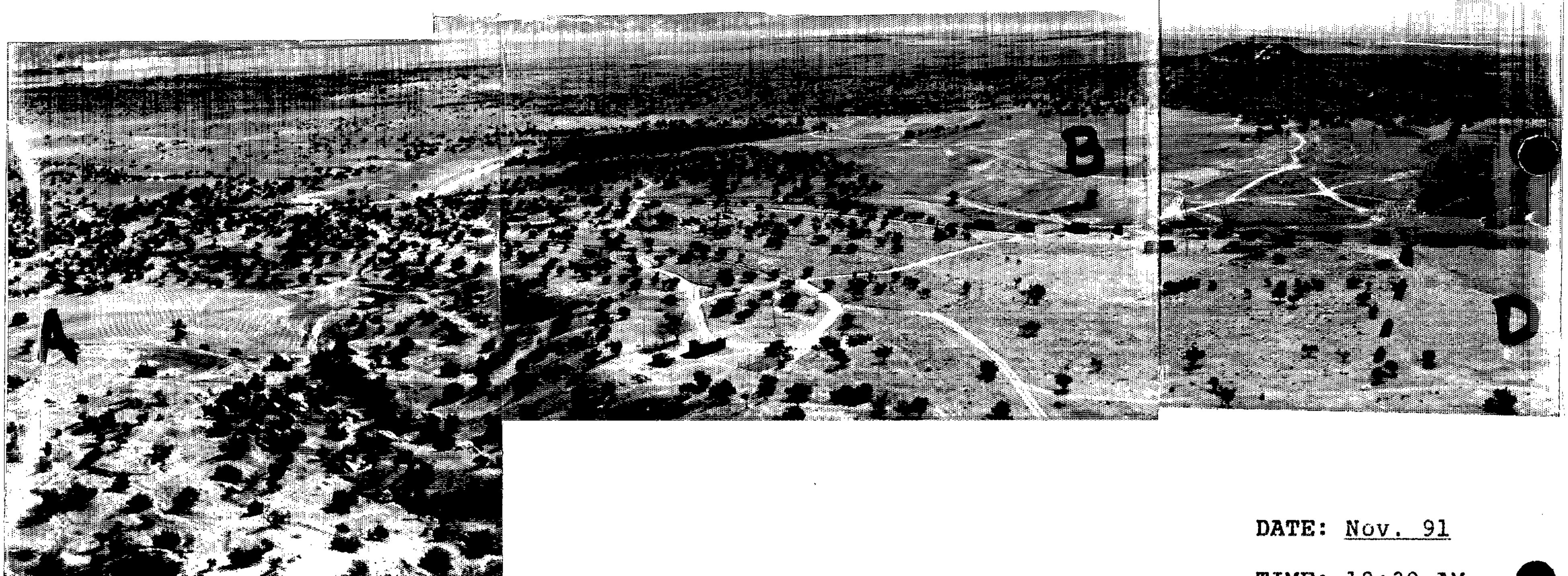
13. Navajo Office of Water Development, "Well Records for Wells #16T-551, #16T-552, #16T-521, #16T-586, and #16B-38," Ft. Defiance, Arizona, 1960.

14. Roybal, F.E., et al., Hydrology of Area 62, Northern Great Plains and Rocky Mountain Coal Provinces, New Mexico and Arizona, U.S. Geological Survey, Water-Resources Investigations, Open-file Report 83-698, Albuquerque, NM, 1984.

APPENDIX A

PHOTODOCUMENTATION

FIELD PHOTOGRAPH LOG SHEET



DATE: Nov. 91

TIME: 12:30 AM

DIRECTION:

South

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:

"A" is reclamated BV Claim in Sec. 18. "B" is reclamated HS Claim in Sec. 19. "C" is reclamated NV Claim in Sec. 24. "D" is DOE Claim. The DOE Claim shown in picture was reclamated some time in the past but to the right are unreclamated mine tailings, vent holes, and a mine decline. Residences are located between "A" and "B". Revegetation of the reclamated areas may have occurred.

FIELD PHOTOGRAPH LOG SHEET

DATE: Nov. 91

TIME: 1:00 PM

DIRECTION:

NE

WEATHER:

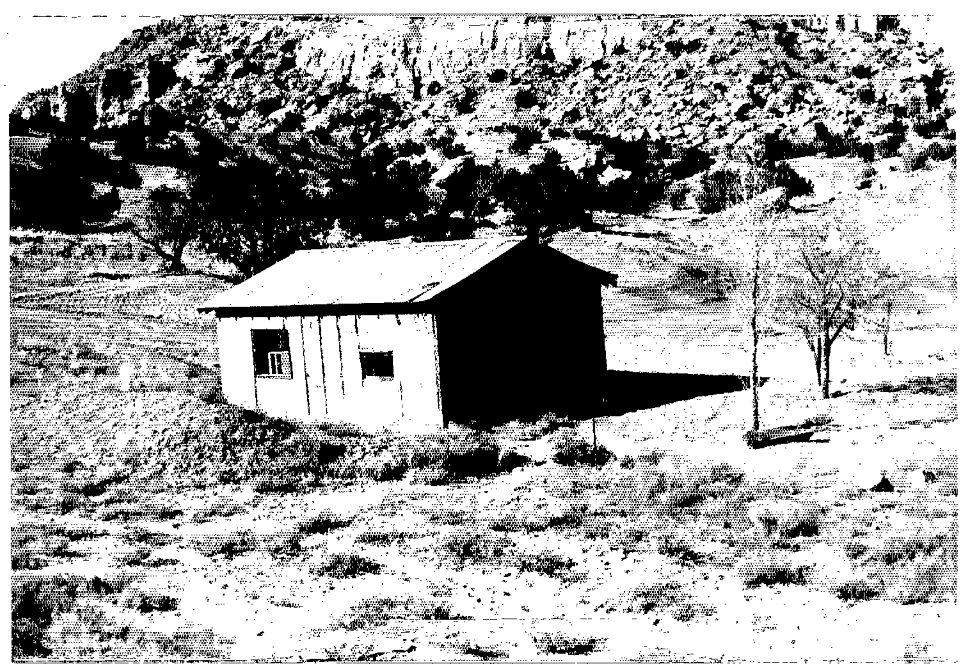
Sunny

PHOTOGRAPH BY:

R. Bauer

DESCRIPTION:

Reclamated HS Claim. Brown Vandever home in background by bus.



DATE: Nov. 91

TIME: 1:25 PM

DIRECTION:

NW

WEATHER:

Sunny

PHOTOGRAPH BY:

P. Antonio

DESCRIPTION:

Former mine office/residence on the reclamated BV Claim.

FIELD PHOTOGRAPH LOG SHEET

DATE: Aug. 91

TIME: AM

DIRECTION:

SE

WEATHER:

Clear

PHOTOGRAPH BY:

R. Bornstein

DESCRIPTION:

Earthmoving reclamation occurring on BV Claim (Sec. 18).

31032

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 1

P. ANTONIO MARCH'92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

September 22, 1991

MEMORANDUM

SUBJECT: OSC Report for the Bluewater Uranium Mine Site, Navajo Nation, Prewitt, New Mexico

FROM: Robert Bornstein RB
On-Scene-Coordinator H-8-3

TO: Joanne Manygoats
Navajo Superfund Program
P.O Box 2946
Window Rock, Arizona 86515

Enclosed for your review is a copy of the On-Scene-Coordinator Report for the ERS response at the Bluewater Uranium Mine Site, Prewitt, New Mexico. As you are aware, ERS conducted a mine reclamation action at the Site to reduce elevated gamma radiation levels and soil radionuclide concentrations.

I want to thank you and your staff for all of the assistance and outstanding support throughout this project. I enjoyed working with you and my stay in New Mexico. It is one of the most beautiful places in America. Please stay in touch and call me if I could be of any further assistance.

If you have any questions about the report please contact me at 415-744-2298.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

FEDERAL ON-SCENE-COORDINATOR'S REPORT

BLUEWATER URANIUM MINE SITES
PREWITT, NAVAJO NATION, NEW MEXICO
AUGUST 11 - SEPTEMBER 19, 1991

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

Printed on Recycled Paper

EXECUTIVE SUMMARY

SITE: Bluewater Uranium Mine Sites

LOCATION: Prewitt, Navajo Nation, New Mexico

PROJECT DATES: August 11- September 19, 1991

The Bluewater Uranium Mine Sites are composed of the Brown-Vandever, Brown-Nanabah and Navajo-Desiderio Mines. The Sites are located approximately five miles west of Prewitt, New Mexico and lie with in the Grants Uranium Mining District. The Brown-Vandever and Brown-Nanabah mines are located on four parcels of land which includes two Indian Allotment parcels, on Federal parcel administered by the Department of Energy and one privately owned parcel.

At the request of the Agency for Toxic Substances and Disease Registry (ATSDR) and the Navajo Superfund Program, EPA ERS was requested to assess the radiological conditions at the sites and to evaluate if a removal action was warranted. A radiological assessment was conducted in November of 1990 by EPA ERS and assisted by the Office of Air and Radiation, Las Vegas.

Elevated gamma emissions (exceeding fifty times background in certain locations) were detected during the assessment. In addition, elevated concentrations of radionuclides were detected within on site soil.

After careful review by EPA ERS, the Office of Air and Radiation (OAR), and ATSDR, it was determined that a response action was warranted at the Sites. After several coordination meetings with several agencies, including the Department of Energy, Department of Interior's Bureaus of Indian Affairs and Land Management, it was decided that EPA should proceed with a response. DOE, which owns portions of the Brown-Vandever Site will conduct its own response on its lands pursuant to Executive Order 12580.

To reduce the immediate potential radiological hazards associated with the two mine sites, ERS conducted the following response actions:

Phase 1

Applied earth cover to effectively reduce gamma radiation emissions and potential for radionuclide migration.

Phase 2

Filled, sealed and capped mine adits, inclines and ventilation shafts to reduce the migration of radon gas emissions.

Phase 3

Revegetated and posted warning signs of reclamated areas.

Post response gamma surveys reveal that the gamma radiation levels have been effectively reduced to natural conditions. EPA and ATSDR concur that the sites have been adequately reclamated to levels which are protective of public health.

TABLE OF CONTENTS

I. SUMMARY OF EVENTS

A. SITE CONDITIONS AND BACKGROUND

1. Initial Situation

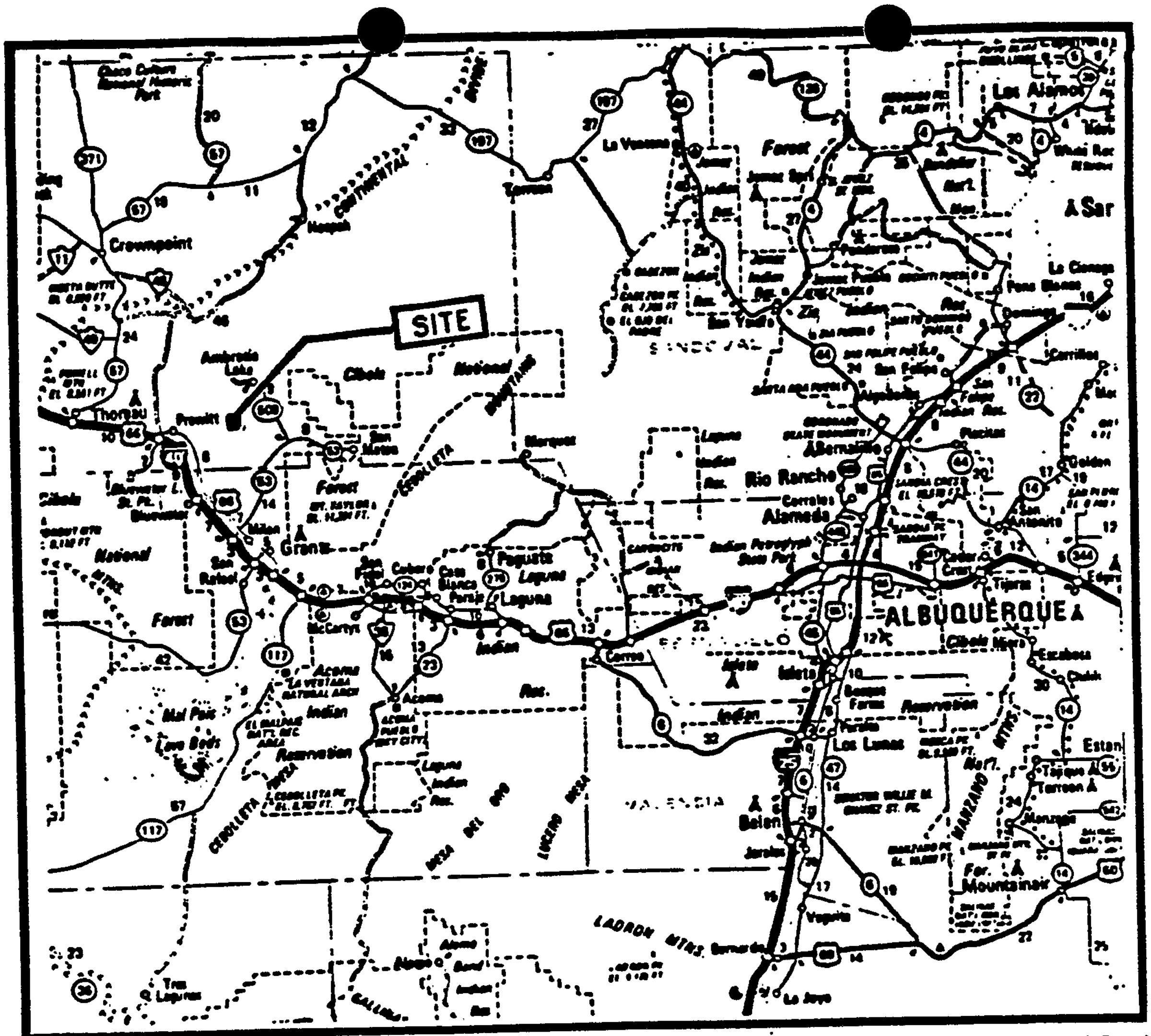
On October 3, 1990, the Emergency Response Section (ERS) was notified by the Agency for Toxic Substance and Disease Registry (ATSDR) of the potential health hazards associated with the uranium mine tailings, waste and debris located at the Brown-Vandever, Brown-Nanabah, and Navajo-Desiderio Mine sites (the Bluewater Uranium Mine Sites). After collecting limited data and conducting several site visits, ATSDR concluded that the Sites may pose a significant health hazard to the local population because of the presence of radioactive mine tailings, physical hazards, and potential for heavy metal contamination. On November 21, 1990, as a result of their investigations, ATSDR issued a Public Health Advisory pursuant to Section 104(i)(6)(H) of CERCLA concerning the Sites.

EPA Region IX ERS was tasked to assess the present radiological and geochemical conditions at the Sites and to determine if an emergency response action was warranted.

The Bluewater Uranium Mine Sites consist of three nearby abandoned mining areas, the Brown-Vandever, Brown-Nanabah and Navajo Desiderio Mine, which are located in the central portion of western New Mexico. The Brown-Vandever and Brown-Nanabah mine sites are located on four parcels of land, which include two Indian Allotment parcels (Section 24, Township 13N, Range 11W and

Section 18, Township 13N, Range 10W), one Federal parcel administered by the Department of Energy (Section 13, Township 13, Range 11W), and one privately owned parcel (Section 19, Township 13, Range 10W). The Desiderio Mine consists of one parcel of Indian Allotment property located on Section 26, Township 13N, Range 10W. All of these parcels lie within the Bluewater U.S. Geological Survey (USGS) Quadrangle (see Figure 1-3). The EPA has conducted response actions on all three Indian Allotments; while Cerrillos Land Company, Santa Fe Pacific Railroad and the Atchison Topeka, and Santa Fe Railway responded to Section 19 under an EPA CERCLA 106 Order. The United States Department of Energy has assumed responsibility in overseeing the response actions on Section 13 pursuant to Executive Order 12580.

The Brown-Vandever and Brown Nanabah parcels are located at the foot of Haystack Butte located approximately five miles west of Prewitt, New Mexico and 15 miles north of Grants, New Mexico. The elevation of the Site varies from 6900 to 7100 feet above sea level. The Desiderio Mine site lies approximately five miles east of the other two sites and is located on Section 26, Township 13N, Range 10W. All of the sites lie within the Ambrosia Lake Subdistrict of the Grants Uranium Mining District. The Brown-Vandever and Brown-Nanabah site encompasses approximately 155 acres, with approximately a third of this area disturbed and scared by uranium mining. The Navajo-Desiderio site covers approximately 130 acres, with nearly 30 acres disturbed by mining



scale 1 in = 20 mi

FIGURE 1
Site Location Map

N

Source: AAA Map
New Mexico
1985

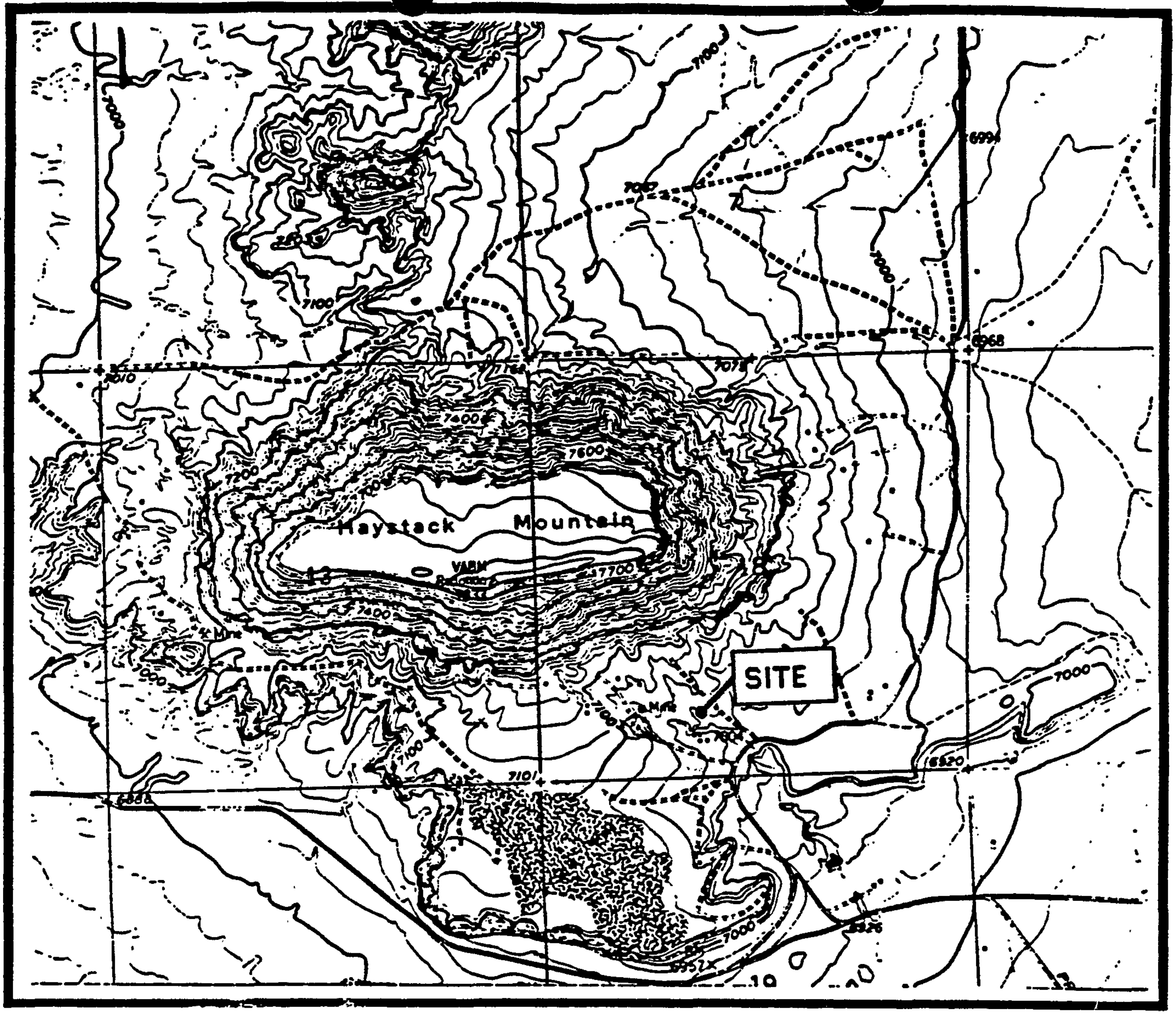


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FIGURE 2
Site Location Map
Navajo Brown Vandever Mine

N

Source: USGS map
Bluewater, NM Quadrangle
1980

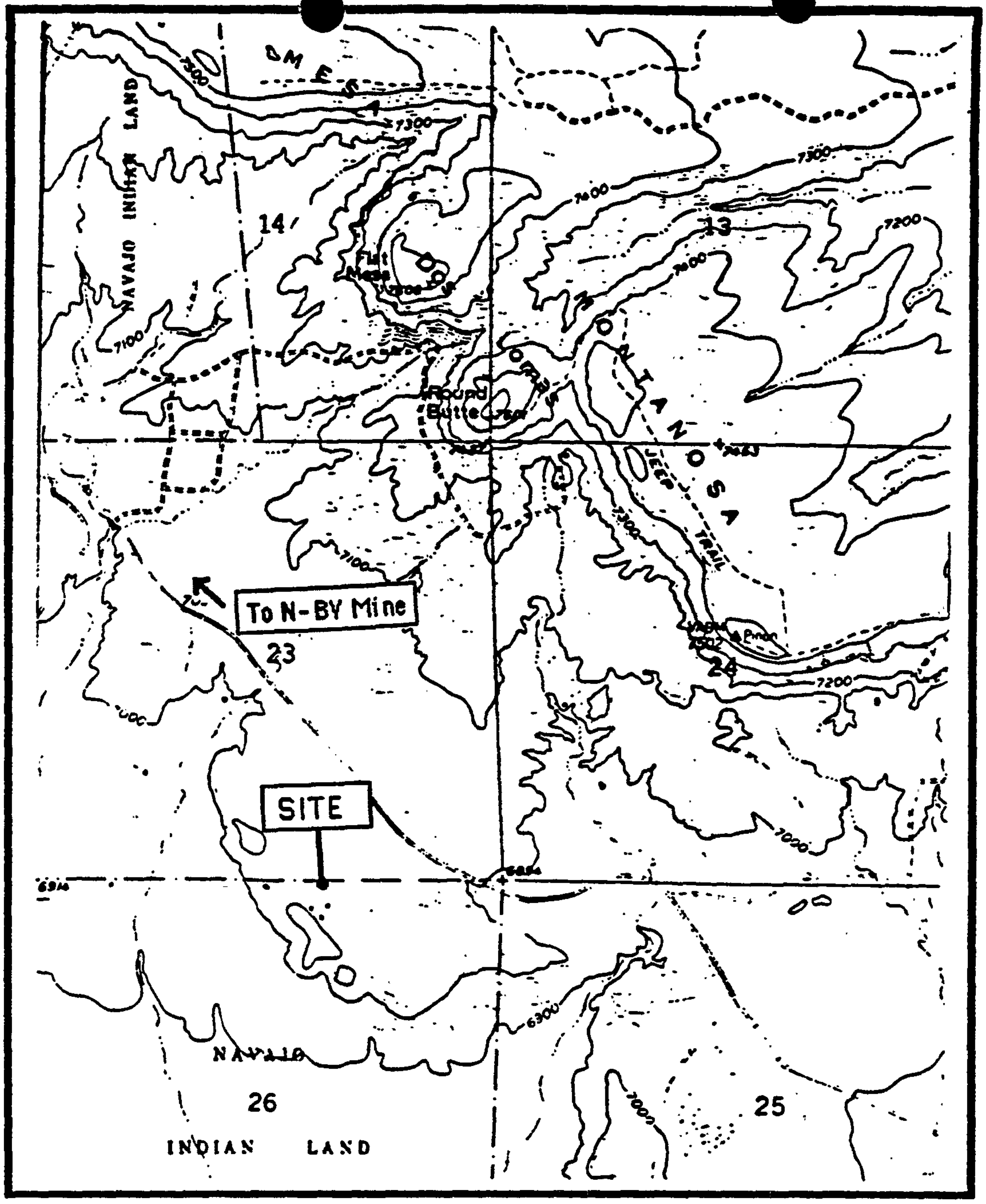

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FIGURE 3
Site Location Map
Navajo Desiderio Mine

N

Source: USGS Map
Dos Lomas, NM Quadrangle
1980

activities (Photo A-D).

Geology locally consists of exposures of Jurassic Todilto limestone and Entrada sandstone. Vegetation consists of sparse grassland and pinyon-juniper woodlands.

Several families live and work near the Site. Approximately forty people, including children, live within one quarter mile of the Brown-Vandever and Brown-Nanabah sites. Approximately thirty people live on the Navajo-Desiderio site. The residents primarily utilize the affected mine areas to graze livestock. In addition, it was reported by ATSDR and the Navajo Nation Superfund that children often play in the mined areas.

2. **Location of Hazardous Substances**

The uranium ore is primarily calcium carnoite, CaO-2UO3-V2O5-nH2O, which disseminates through the Todilto limestone. Operations at the sites consisted of both open pits and underground mining techniques. Open pit mining was conducted predominantly with large front end loaders and haul trucks. The overburden, consisting of topsoil, alluvium and sandstone was blasted, removed and placed in large waste piles. It is estimated by the Navajo Nation that 25,000 tons of uranium ore was removed from these sites. Mined ore which failed to contain significant quantities of uranium were discarded at the mine sites; and no formal reclamation program was undertaken after mining operations ceased. Because of the dry climate and lack of chemical weathering, these mining tailings and waste remained exposed and

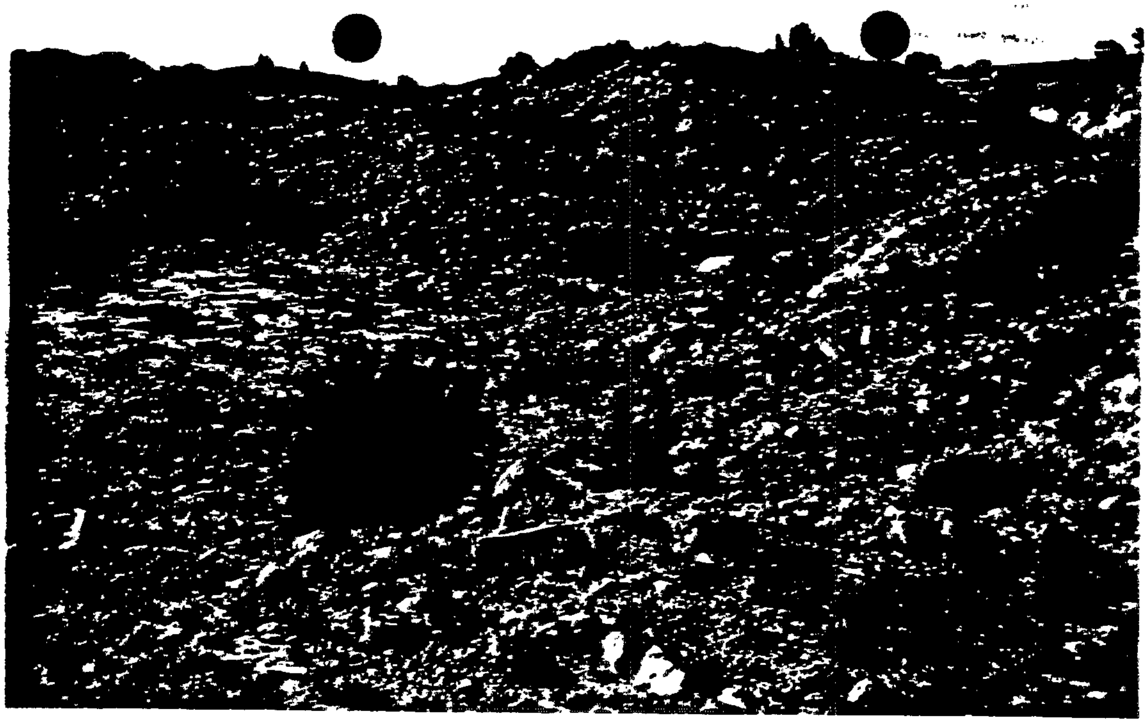


Photo A. Mine waste and protore (low grade ore) on Section 24, Brown-Vandever Allotment. (photo by Robert Bornstein)

Photo B. Open mine adit located on the Navajo-Desiderio Mine Site. (photo by Craig Dodd, REAC)

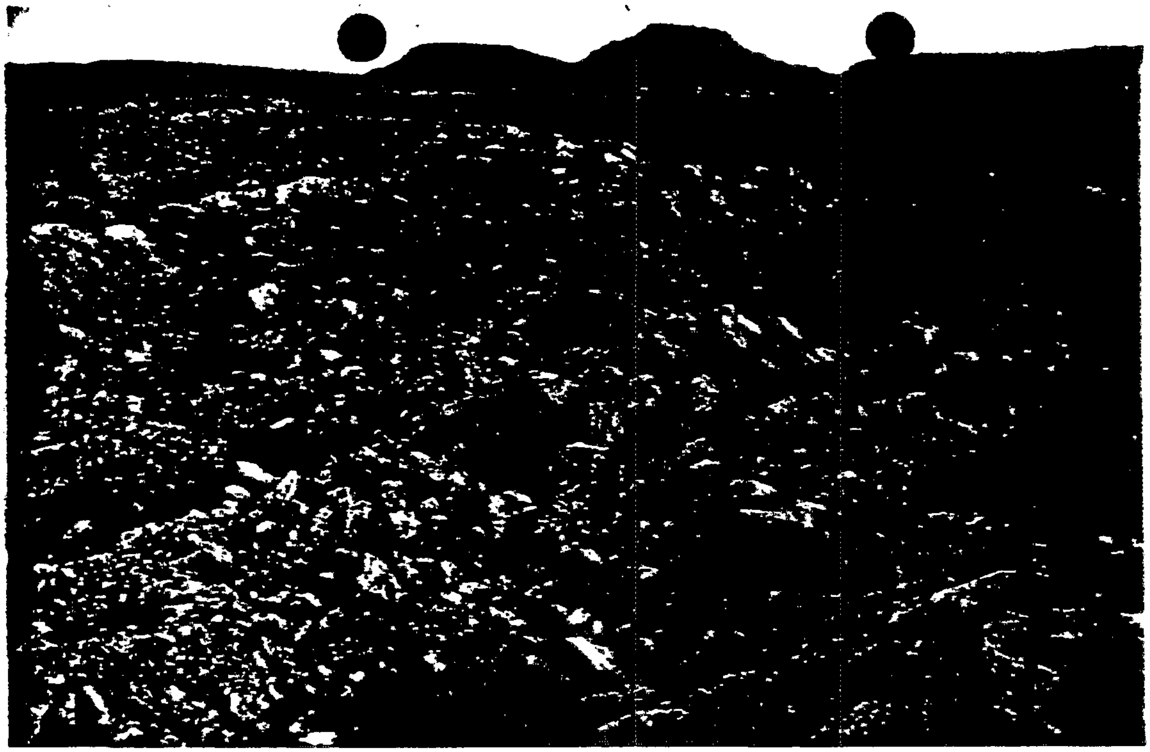


Photo C. Protore (low grade uranium ore) and overburden piles on the Navajo-Desiderio Mine site looking North from residence. (photo by Robert Bornstein)

Photo D. Large open pits and protore on the Navajo-Desiderio Mine Site looking east from residence. Mt. Taylor in background. (photo by Brad Shipley).

the landscape scared.

3. **Cause of the Release or Discharge**

As a result of mining operations, uranium bearing rock and soil littered the Sites. On November 15-16, 1990, the ERS staff, assisted by members of the EPA Office of Air and Radiation, conducted a field gamma survey and collected water and soil samples on and about the Brown-Vandever, Brown-Nanabah, and Desiderio Mine sites.

In order to assess the conditions present at the sites, the ERS staff using standard radiation detection equipment (Ludlum model 19), first obtained background radiation measurements at a distance of 2.5 miles, 1.0 mile and approximately .5 miles from the sites. ERS staff took radiation readings at several sampling locations within the immediate vicinity of the sites. Measurements were taken at both ground level and at waist level. Waist level measurements are indicative of human exposure levels, whereas the contact measurements taken at ground level suggest the emission rate of the radioactive materials from the soil.

Ground level background readings obtained by the ERS staff ranged from 11 microroentgens per hour (uR/hr) to 20 uR/hr, while waist level background readings ranged from 11 uR/hr to 15 uR/hr. Within the immediate vicinity of the sites, the net waist level (background subtracted) radiation levels ranged from 20 uR/hr to over 750 uR/hr. On ground contact, the maximum on-Site radiation level was recorded over 1000 uR/hr.

Elevated concentrations of radium (Ra-226/228) and uranium isotopes (U-223/224/235/238) were also detected in on-site soils. The maximum levels detected for radioisotopes in surface soils at the sites (within the top 15 centimeters of soil) were radium, which was measured in excess of 260 picocuries per gram of soil (pCi/g) and for uranium species, which were measured at more than 300 pCi/g. Soil samples which were analyzed for heavy metal contamination <u>did</u> <u>not</u> reveal any significant amount of contamination.

A more through gamma survey was conducted on August 11-19, 1991 by EPA on Section 24 (Brown-Nanabah) and Section 18 (Brown-Vandever) and Desiderio Site prior to reclamation activities (See Appendix A). The surveys were conducted using a 50 foot by 50 foot grid. Figures 4-6 show the respective results from the surveys.

Radiation is a known carcinogen, mutagen and teratogen. Exposure to elevated gamma radiation is known to cause cancer, cataracts, and shorten the life span of affected individuals. As indicated above, elevated radionuclide levels were detected at the sites in both the soil and waste materials. These radionuclides have been found to emit radiation at levels which may present a danger to populations in the vicinity of the Site. Uranium and several of its decay daughters are alpha emitters. The inhalation of radionuclides that are alpha emitters exposes an affected individual's internal organs to damaging alpha radiation. Once

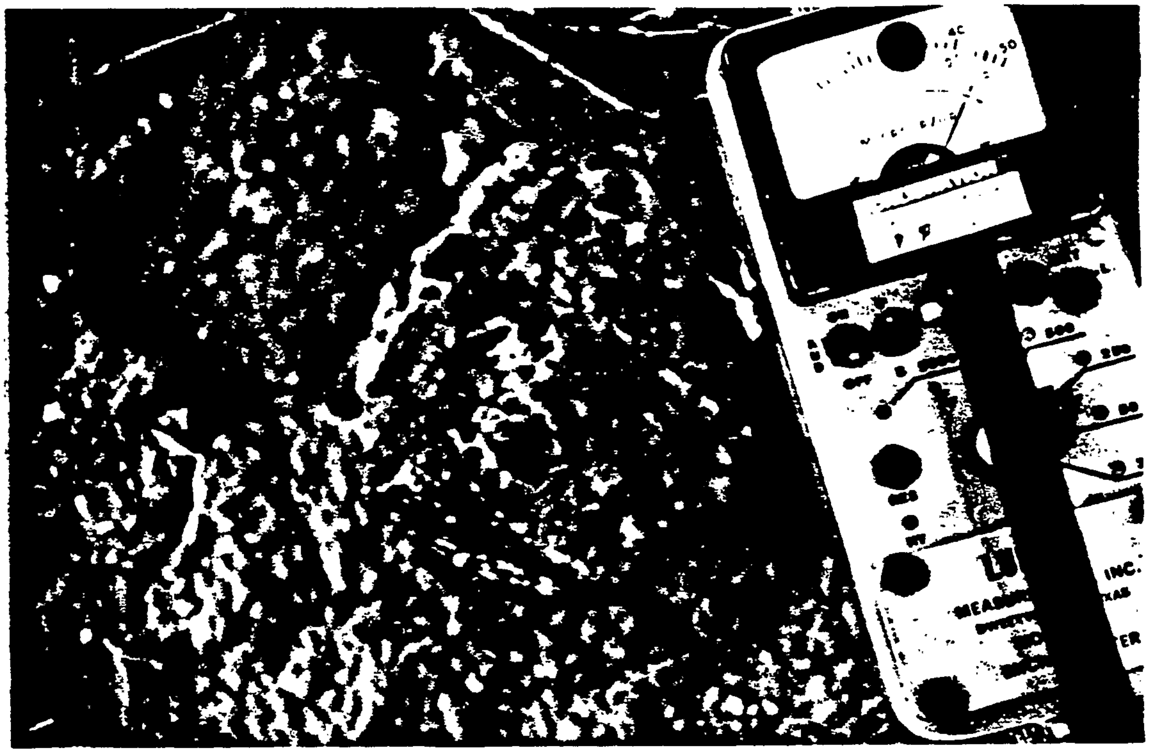
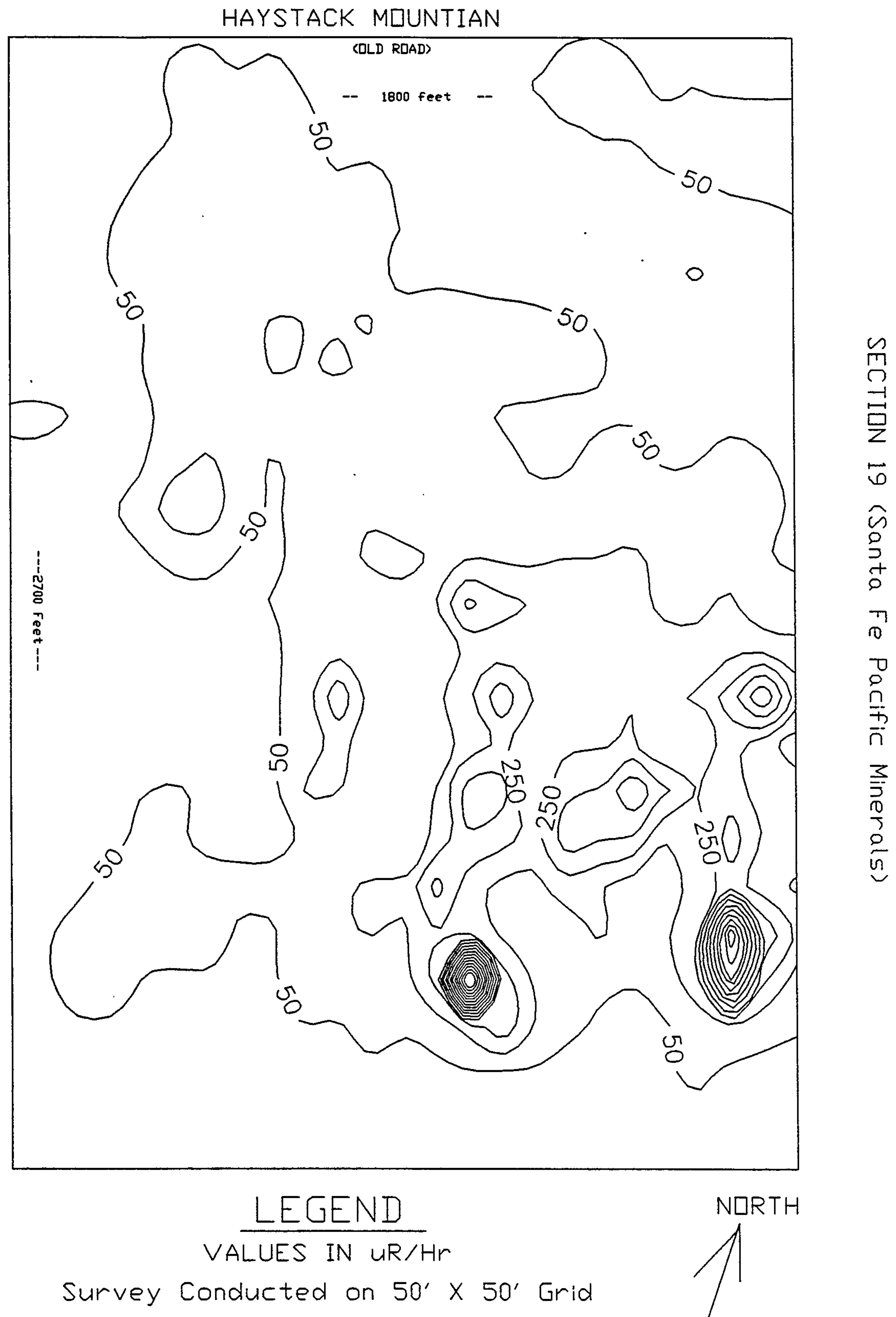


Photo E. Todilto limestone containing uranium ore. Meter is reading 230 uR/hr. (photo by Jerry Gels, REAC)

Photo F. Gamma survey being conducted by Chris Dodd, REAC on Section 18 (Brown-Vandever). (photo by Robert Bornstein)

Figure 4.

PRE-RECLAMATION
NANABAH ALLOTMENT (SEC. 24, T13N, R11W)



LEGEND

VALUES IN uR/Hr

Survey Conducted on 50' X 50' Grid

Waist Level Measurements

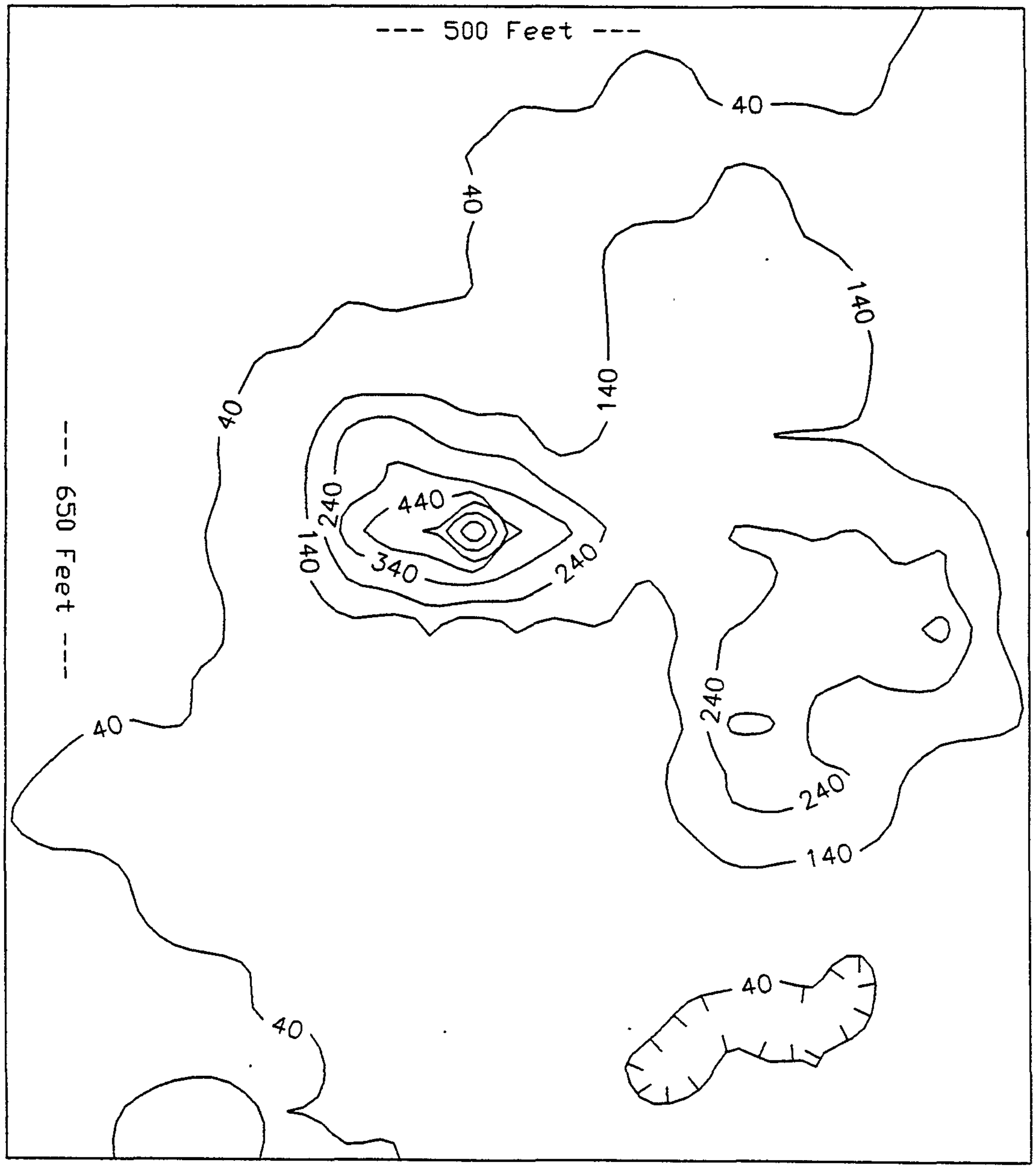
100 uR/Hr Contour Interval

ERS Graphics 9/91

Figure 5.

PRE-RECLAMATION

BROWN-VANDEVER ALLOTMENT (SEC. 18, T13N, R10W)



LEGEND

VALUES IN uR/Hr

Survey Conducted on 50' X 50' Grid

Waist Level Measurements

100 uR/Hr Contour Interval

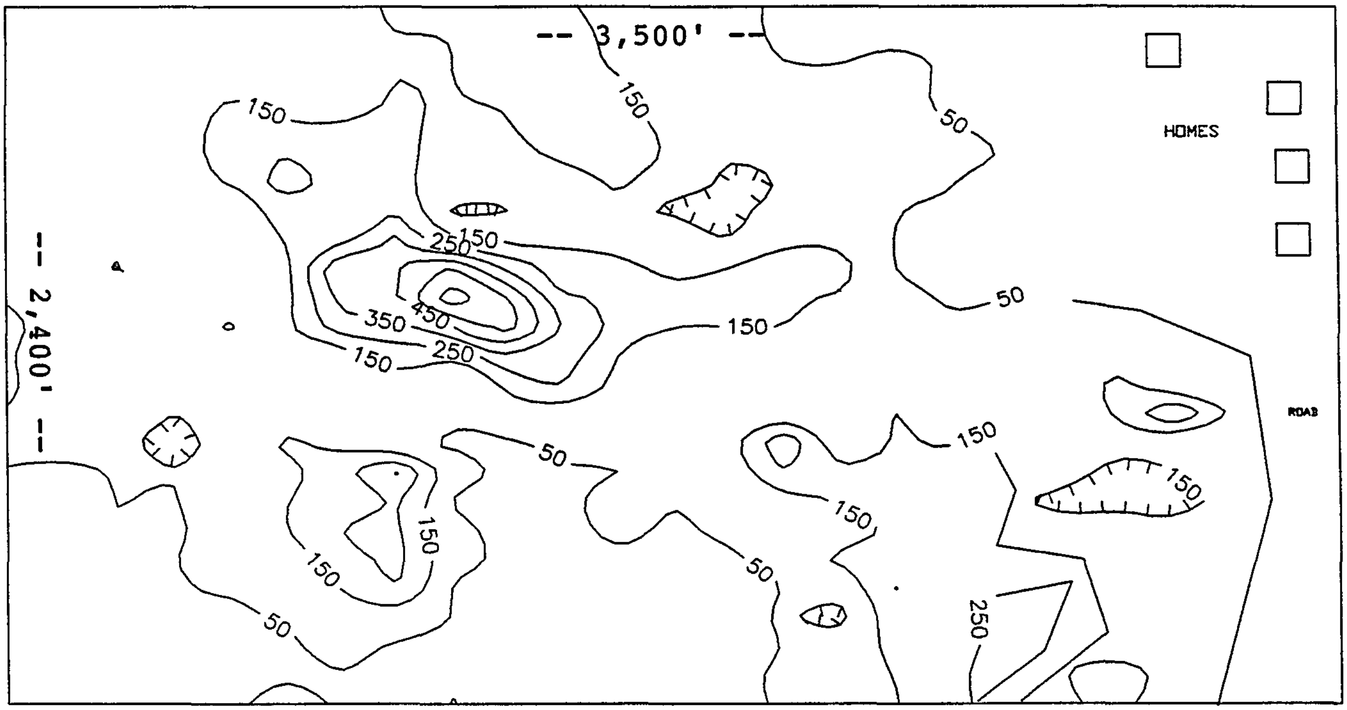
NORTH

ERS Graphics 9/91

Figure 6.

PRE-RECLAMATION

NAVAJO-DESIDERIO MINE SITE



LEGEND

VALUES IN uR/Hr

Survey Conducted on 100' X 100' Grid

Waist Level Measurements
100 uR/Hr Contour Interval

N

ERS Graphics 9/91

ingested, the alpha emitters become trapped within the body, and can thereby cause severe organ damage as well as certain genetic defects.

4. <u>Efforts to Obtain Response by Responsible Parties</u>

a. <u>Federal and Indian Allotments</u>

The Bluewater Uranium sites consist of parcels administered, owned and/or operated by several entities. An interagency task force consisting of representatives of the Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), Department of the Interior (DOI), Department of Energy (DOE), EPA, Navajo Nation Superfund Program (NSF), Indian Health Services (IHS), and ATSDR was organized to discuss response options for the sites. The Region IX Emergency Response Section (ERS) began an ongoing dialog with local and regional BIA and DOI representatives in late 1990, in order to ensure close coordination between all Federal Agencies regarding a response action at the Bluewater Sites. To acquire specific information regarding the leases at the Sites, EPA issued BIA a CERCLA 104 Request for Information. Several of the leases on the Indian Allotments contained reclamation clauses that appeared not to be enforced.

On April 8, 1991, members of the BIA, BLM, DOI, IHS and Navajo Nation met to discuss response activities. EPA ERS could not attend the meeting in Albuquerque because of travel restrictions. At the meeting, it was determined that EPA most likely could provide the most expedient response.

A second Interagency meeting was held on June 3, 1991 to visit the Sites and discuss the time critical actions and potential cooperative agreements. At this meeting, the DOE stated it would assume full responsibility in conducting response actions on the DOE parcel (Section 18).

At this meeting DOI OEA stated it would try to enter into an Interagency Agreement (IAG) with EPA to conduct the response activities on the Indian Allotments. Several drafts of the IAG were created and revised by both EPA and DOI OEA.

For several months, an effort to develop an IAG for the response action was undertaken by ERS and DOI representatives. Pursuant to the terms of the negotiated IAG, ERS was to conduct the response activities at the site, and DOI was to reimburse EPA for specified costs of the response, pursuant to its authority under the Snyder Act.

In drafting the IAG, EPA Region IX was well aware of DOI's sensitivity concerning the possible precedent which the Agreement might establish for the remediation of other BIA-adminstered mining sites. In light of this concern, EPA Region IX crafted site-specific IAG language, to minimize the implication of BIA liability for site remediation under CERCLA. While the proposed IAG still referred to CERCLA (as the statutory basis for EPA's response activity at the sites), it also specifically referenced the Snyder Act (as the authority supporting BIA reimbursement of

EPA's response costs). Furthermore, the IAG itself stated that BIA's agreement to pay EPA for certain costs of the response action would in no way constitute an admission of liability under the Act. Finally, a special condition to the IAG clearly indicated that the Agreement was not to be viewed as a precedent for the payment of EPA's response costs at other sites in Indian country.

Since the time of the first Interagency meeting concerning the Bluewater sites, it has been EPA's understanding that DOI representatives in Washington D.C. had been generally apprised of the development of the IAG, and had received copies of the relevant correspondence concerning this cooperative effort. Based on this understanding, EPA sent the proposed agreement to DOI Assistant Secretary John Schrote for signature on July 15, 1991.

Thereafter, on August 1, 1991, DOI representatives informed EPA Region IX that, contrary to previous indications from local and regional DOI officials, the DOI would not agree to participate as a signatory to the IAG.

DOI officials believed that the Agreement might be viewed by other parties as a precedent for future response actions. DOI proposed to EPA that it would perform the necessary response actions on the Indian Allotments.

In response to DOI's concern, EPA first offered to revise the IAG, to incorporate any new language that DOI might suggest. However, DOI responded that it was the very concept of the IAG, rather than its specific language, that was objectionable to the Department. EPA then indicated that it would consider DOI's proposal to perform the response action. However, EPA stressed the need for prompt action at the sites. A deadline of August 5, 1991 was agreed upon for DOI to submit to EPA a work plan outlining its response action and schedule. The August 5 deadline passed without any additional communication between DOI and EPA. On August 6, EPA still did not receive a firm commitment from DOI to promptly initiate work at the sites. DOI informed EPA that it was having problems obtaining the required funding to perform the site response and that a special request to Congress was required. This request was estimated to take at least two to three weeks.

Given the serious health hazards which the sites posed and the need for prompt action to abate those hazards, EPA had no choice but to proceeded on schedule to undertake the required response activities.

EPA is coordinating with the EPA Headquarter Federal Affairs Office and the Department of Justice to further investigate options on seeking cost reimbursement from DOI.

b. Private Land

EPA conducted a Potential Responsible Party search to investigate the historical mining records. The PRP search revealed that the mineral rights for Section 19, Township 13N, Range 10W was held and controlled by the Santa Fe Pacific Railroad Company (SFPR). SFPR owned the mineral rights to the site for the period from 1951 to the early 1980's. During this period of time, uranium mining operation were conducted at the site. In mid-1980, mineral rights were transferred to Cerrillos Land Company, a SFPR company.

From November 21, 1950, to September 30, 1952, SFPR conducted drilling, sampling, test pitting and other mining operations at the Site. According to the mineral leasing history and corporate chronology supplied to EPA by Mr. Tim Leftwich, Director of Environmental Quality for both the Cerrillos Land Company (CLC) and the Santa Fe Pacific Minerals Corporation (SFPM), the Haystack Mountain Development Company (HMDC) was incorporated on October 15, 1951, as a subsidiary of the Atchison, Topeka and Santa Fe Railway. From September 30, 1952 to November 30, 1961, SFPR formally leased the mineral rights to Section 19 to HMDC. From September 30, 1952 to November 30, 1961, HMCD conducted mining operations on Section 19.

From the mining history record, EPA served a CERCLA 106 Unilateral Order to Cerrillos Land Company, Santa Fe Pacific Railroad Company and the Atchison, Topeka and Santa Fe Railway Company (ATSF) on July 29, 1991.

On August 13, 1991, a conference was held in Albuquerque with the respondents of the Order. It was agreed upon that Cerrillos Land Company would assume the "lead" entity during the response action and that the respondents would comply with the Order.
On August 26, 1991, Taylor Excavation mobilized on Section 19 to

begin reclamation activities for Cerrillos Land Company.

B. ORGANIZATION OF THE RESPONSE

On June 10, 1991, Jeff Zelikson, Director, Hazardous Waste Management Division, Region IX approved the Action Memorandum. Pursuant to OSWER Directive 9360.0-19, the Bluewater action is considered nationally significant, and therefore, required EPA Headquarter's concurrence. After much anticipation, on July 26, 1991, Henry Longest, Director of the Office of Emergency and Remedial Response concurred on the Action Memorandum. With Headquarters approval, ERS prepared to conduct the response.

The response action was conducted in three phases. Phase 1 contained activities to further characterize and define areas with elevated gamma radiation readings; Phase 2 dealt with the excavation and covering of uranium ore, mine waste, and closing of shafts and adits; and Phase 3 involved revegetation activities and the posting of warning signs.

* Phase 1 Definition and Extent of Problem
  - Conduct extensive gamma survey using a 50' X 50' grid.
  - Evaluate soil and overburden piles for use as cover.
* Phase 2 Excavation and Earth Moving Activities
  - Fill and cover in all open pits with radioactive materials.
  - Reduce elevated gamma radiation readings to below 50 uR/Hr.
  - Fill and Close all shafts, adits and inclines.
  - Conduct Post Removal gamma surveys to ensure proper clean-up levels.

* Phase 3 <u>Revegetation and Posting</u>

  - Disk and Drill seed mixture.

  - Post warning signs in English, Navajo and Spanish to advise people to not disturb the reclamated surface.

To conduct Phase 2 and 3 activities, EPA Region IX contracted with Laguna Construction Company. A site specific contract was negotiated between Jeri Simmons, Region IX Contracting Officer and Neal Kasper, President of Laguna Construction. Laguna Construction was selected by EPA Region IX for the following reasons:

* <u>Experience in the field of Uranium Mining Reclamation</u>

Laguna Construction was established with the assistance of the Bureau of Indian Affairs and the Publeo of Laguna to perform the mine reclamation action at the Jackpile Mine, the world's largest open-pit uranium mine. Laguna construction has moved over 11.8 million cubic yards of material at Jackpile and has built an outstanding track record in mine reclamation actions.

The Bluewater response action required similar actions and expertise demonstrated by Laguna Construction at Jackpile. In addition, Laguna Construction was the most qualified mine reclamation contractor in the Bluewater-Grants Mining District. The company was familiar with the regional geology and topography.

* <u>Minority owned and Operated Business</u>

It is the policy of the EPA to enter into contracts with small minority business that could adequately perform the tasks. Laguna Construction is a wholly owned and operated enterprise of the Pueblo of Laguna Indians. EPA wishes to use an Indian owned and operated company on Indian Lands.

EPA Region IX believed that a site specific contract to conduct this action would be more practical and cost efficient rather than issuing a delivery order to the present ERCS contractor.

To assist in conducting the radiological surveys and providing site health physicist support, ERS utilized the expertise and experience of the Environmental Response Team's (ERT) radiological support staff and its contractor Weston (REAC). Additional radiological support was provided to ERS by EPA Region IX Office of Air and Radiation (OAR). Both ERT/REAC and OAR provided invaluable support and expertise throughout the response action. Additional site support was provided by the Navajo Superfund Program (NSP). Table 1 outlines the organization of the response and lists key site personnel contacts.

C. INJURY/POSSIBLE INJURY TO NATURAL RESOURCES

Wildlife species in the area of the Sites are restricted to birds, reptiles, and small mammals characteristic of the pinyon-juniper and grassland habitats. This includes rabbits, foxes, field rodents, rattlesnakes, hawks, blue birds, and other creatures. Livestock utilizing the sites are horses, cows, goats and sheep. Continuous exposure to the elevated gamma emissions could adversely impact local wildlife and grazing livestock.

2. Trustee Damage Assessment and Restoration Activities

No formal endangerment assessment was performed at the sites by the Department of the Interior or EPA.

The affected reclaimed areas were revegetated using native

Table 1. Organization of Response

AGENCY/PARTY	CONTACT	DESCRIPTION OF DUTIES
USEPA-REG IX Emergency Response H-8-3 75 Hawthorne Street SF, CA 94015 415-744-2298	Rob Bornstein	Federal OSC, responsible for all site operations
	Bill Weis	Enforcement Investigator Cost Recovery Specialist
USEPA-ORC 75 Hawthorne Street SF, CA 94105 415-744-1359	Linda Wandres	Attorney assigned to the site
USEPA-OAR 75 Hawthorne Street SF., CA 94105 415-744-1049	Steve Dean	Health Physicist Radiation Support
USEPA-ERT 26 W. MLK Dr. Cinn., OH 45268 513-569-7537	Art Ball	ERT Response Manager Radiation Support
Weston REAC 11 Spiral Dr. Suite 6-7, Bldg. B Florence, KY 41042 606-282-7868	Jerry Gels	Health Physicist Radiation Support
	Craig Dodd	Radiation Support
Navajo Superfund P.O. Box 2946 Window Rock, AZ 602-871-7331	Pat Antonio Stan Edison Guarva Rajen	Assisted in PA/SI and Response Support
Laguna Const. P.O. Box 206 Laguna, NM 87026 505-552-6000	Neal Kasper Jack Presnell	Prime Contractor conducting response

grass species. Additional pinyon and juniper trees will be planted by the Navajo Nation in early Spring of 1992.

D. CHRONOLOGICAL NARRATIVE OF RESPONSE ACTIONS

1. THREAT ABATEMENT ACTION TAKEN

a. Phase 1

Phase 1 activities commenced on August 12, 1991. OSC Bornstein assisted by Art Ball (ERT), Jerry Gels (REAC), Ken Munney (REAC) and the Navajo Superfund laid out a 50 foot by 50 foot grid across the hummocky topography on Section 24 and Section 18 of the Brown-Vandever-Nanabah Allotments. The grid was laid across an area of 1800 feet East-West by 2700 feet North-South on Section 24 and 650 feet North-South by 150 feet East-West across Section 18. A modified 50 foot by 50 foot survey utilizing the site's aerial photograph was performed on the Desiderio mine site (refer to Figures 4-6).

After the grids were established, a Ludlum model 19 instrument was utilized to conduct a thorough gamma survey. Gamma readings were collected at both waist level and ground contact at each grid node. A second survey was conducted at waist level targeting limestone contacts and rubble to pin point "hot spots."

During the week of August 11, 1991, surveyors from Laguna Construction surveyed and developed contour maps on each affected section.

b. Phase 2

Phase 2 activities began on August 19, 1991 with the mobilization of Laguna Constructions equipment and personnel. Mobilized on site to conduct the earth moving activities were three Cat D-9N dozers, one Cat D-6H dozer, one Cat 14G grader and one Cat 980C front end loader. In addition, Laguna Construction mobilized a lube and fuel truck, mechanic truck, fuel storage tank, and lunch room. All of the equipment arrived on schedule and in excellent working condition.

Earth moving activities began on Section 24 (Brown-Nanabah Allotment) on August 19, 1991. The D-9N dozers were utilized to push and cut the large piles of overburden fill. Piles containing "clean" fill (gamma readings of 20 uR/hr or less) were isolated and stockpiled for use as cover material. The large pits were first back filled with protore (low grade ore) and mine tailings and then covered with 1-3 feet of "clean" fill. After an area was completed, a gamma survey was conducted to ensure that gamma levels were under 50 uR/hr. Areas exceeding 50 uR/hr were flagged by ERT/REAC personnel and latter reworked. Laguna Construction completed earth moving activities on Section 24 on August 27, 1991. From August 27-31, earth moving activities were performed on Section 18.

Activities on Section 18 included back filling a large open adit, recontouring area drainage channels away from reclamated zones, and installing a drainage culvert.

On September 2, 1991, all of the tractors and support equipment were transported to the Navajo-Desiderio site. Earth moving activities on the Desiderio site included the back filling of several large (up to 30 feet deep and 50 yards across) pits, the sealing and closure of a mine adit, the transportation, burial and covering of large protore piles, and the rechannelling and grading of drainage channels. Earth moving activities at the Desiderio site were completed on September 18, 1991. A 100 foot by 100 foot survey was conducted over the reclamated area to ensure that gamma radiation readings were below 50 uR/hr. Laguna Construction demobilized its equipment on September 19-20, 1991.

Throughout earth-moving activities, REAC conducted air monitoring using an aerosol particulate monitor to assess if level C personnel protection was necessary. At no time was level C personnel protection required during the response. Appendix B summaries the results of this study. Photos G-N show Laguna Construction equipment at work.

c. Phase 3

Phase 3 activities began in early September with the posting of the warning signs. The signs were placed along the perimeter of each reclamated section. Each sign was in English, Navajo and Spanish (see photo O). James Ranch was subcontracted by Laguna Construction to perform the revegetation activities. On September 18, 1991, James Ranch personnel and equipment mobilized at the Brown-Vandever site. The reclamated zones were disked and drill seeded using a mixture of native grasses. By September 21, 1991, James Ranch completed the job reseeding 70 acres of reclamated

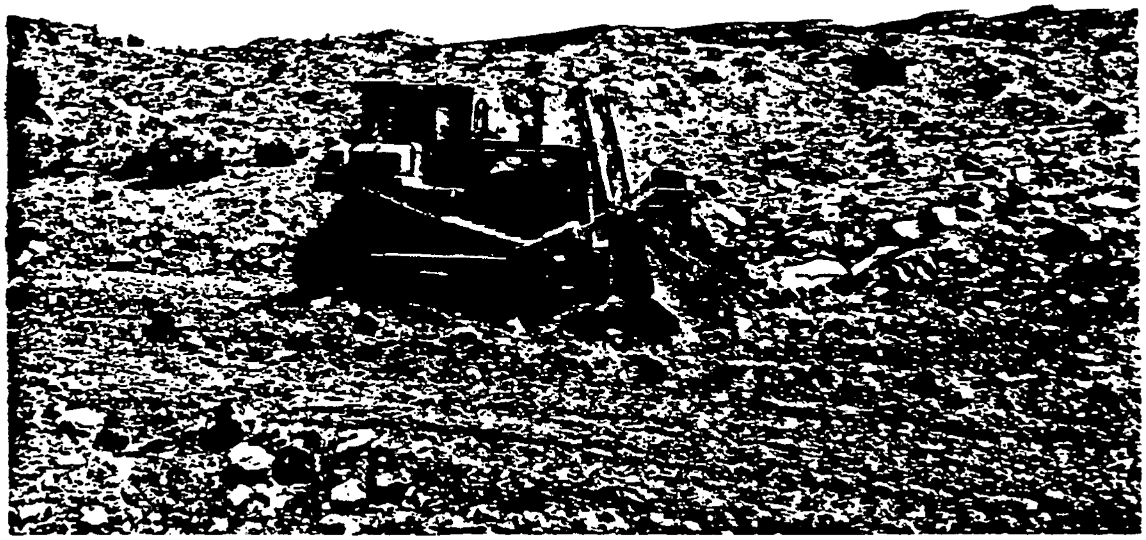


Photo G. Laguna Construction Cat D-9N pushes mine tailings and protore on Section 24 (Brown-Nanabah). (photo by Robert Bornstein)

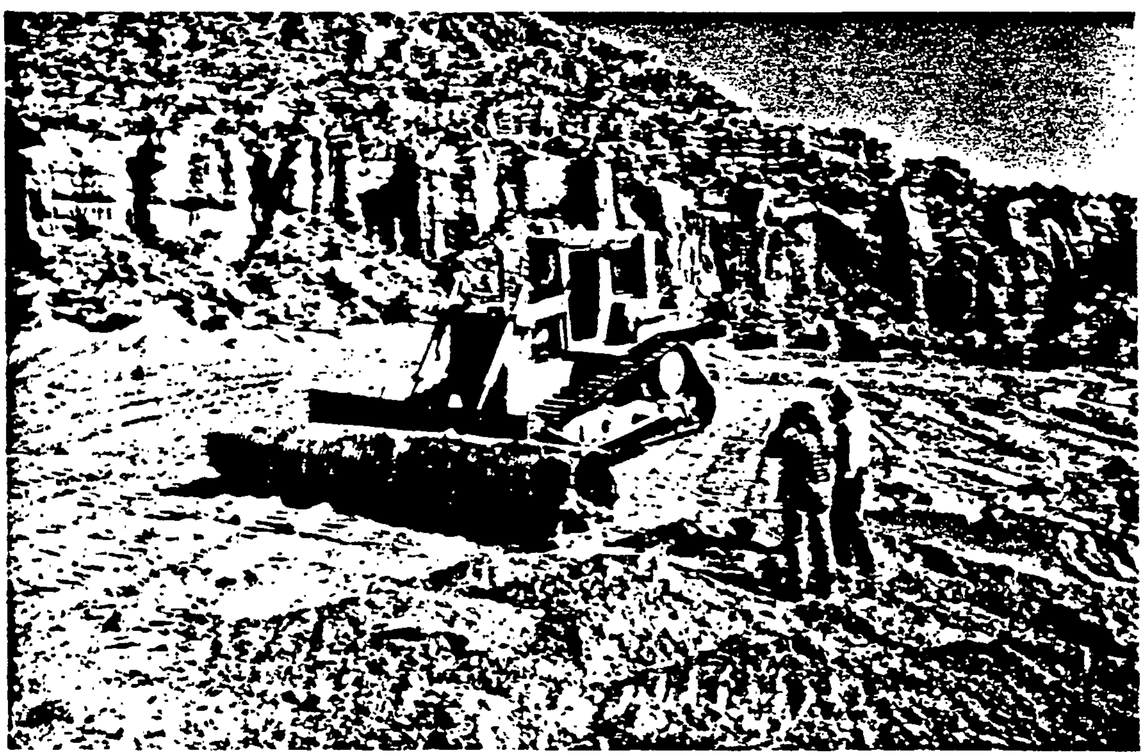


Photo H. Drainage colvert being installed by Laguna Construction on Section 18 (Brown-Vandever). Drainage routes were directed around reclamated areas. (photo by Jerry Gels, REAC)

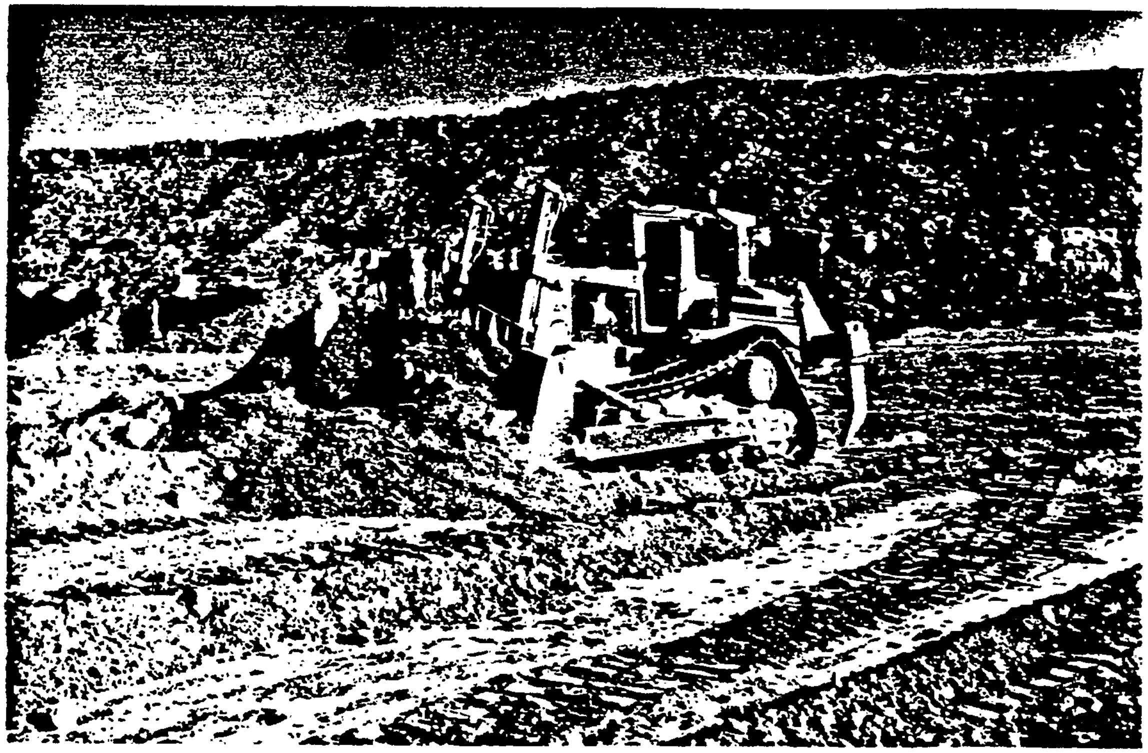


Photo I. A D-9N pushes "clean" fill over burried protore and mine tailings on Section 24 (Brown-Nanabah). Note, Haystack Mountain in background. (photo by Robert Bornstein)

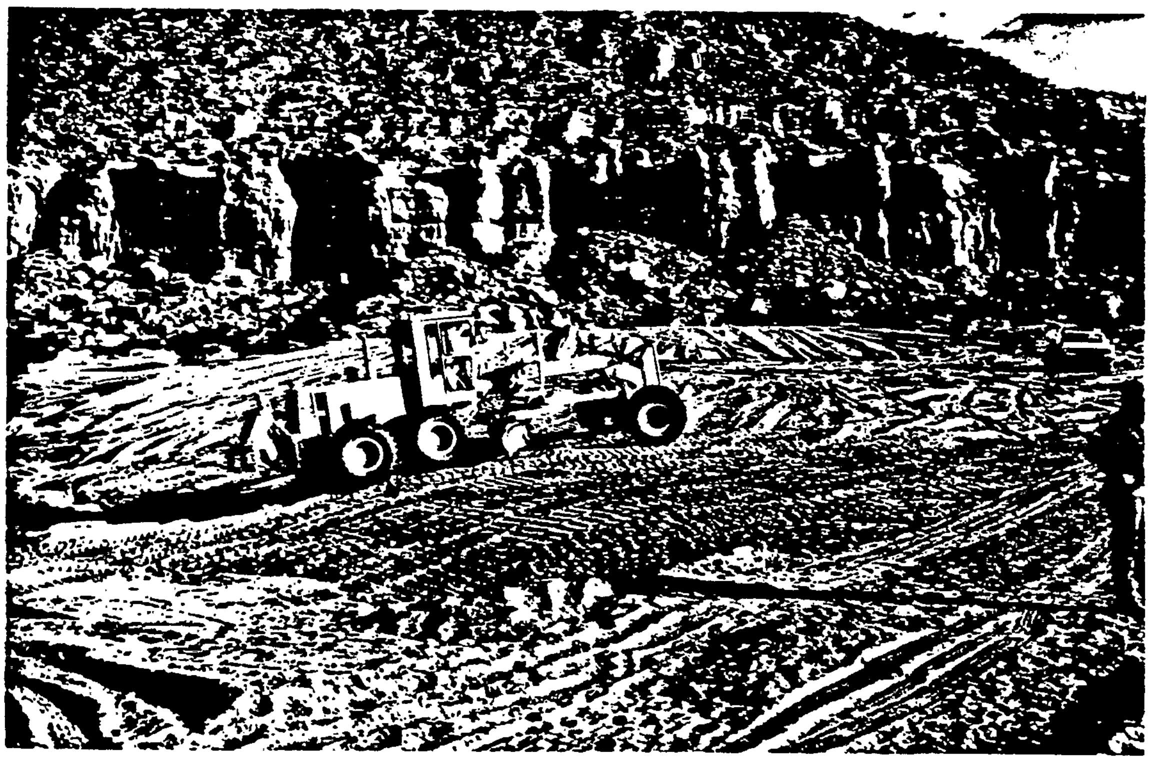


Photo J. A Cat 14G road grader was utilized to smooth the dozer wind rows and prepare the site for reseeding. Photo is taken looking north on Section 18 (Brown-Vandever). (photo by Robert Bornstein)

Photo K. A D-9N tractor pushes mine tailings and overburden into one of the many large open pits at the Desiderio Mine Site. (photo by Robert Bornstein)

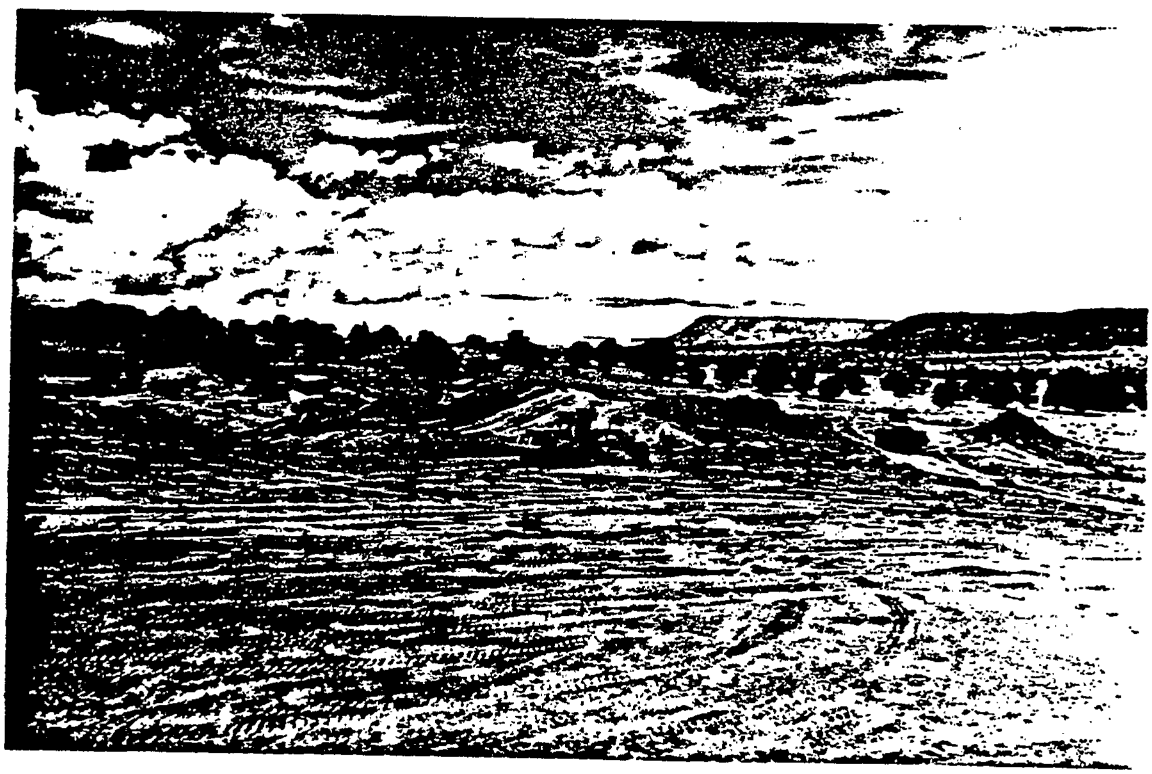


Photo L. D-9N tractors, Cat 14G road grader and a 980C-front end loader complete mine reclamation activities on the Desiderio Mine Site. (photo by Robert Bornstein)

Photo M. A D-9N completes the finishing smoothing activities on Section 18 (Brown-Vandever). (photo by Robert Bornstein)

Photo N. Two massive D-9N work to fill in large pit on the Desiderio Mine Site. (photo by Robert Bornstein)

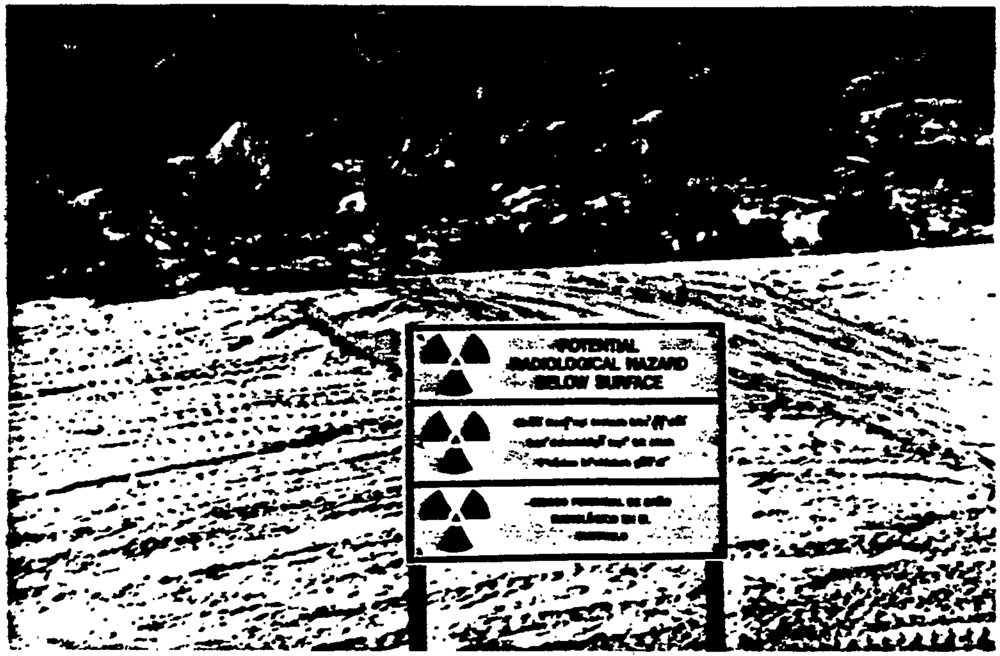


Photo O. Posted warning sign on Section 18 (Brown-Vandever). Note that the signs are in three languages: English, Navajo, and Spanish.(photo by Jerry Gels, REAC)

Photo P. Completed Section 24 looking south-easterly from section line. (photo by Jerry Gels, REAC) land.

3. Public Information and Community Relation Activities

EPA's Office of External Affairs issued a press release informing the media of the response action. In addition, a Navajo Nation sponsored Press Conference was held on August 28, 1991 at the Baca Chapter House. Navajo President Peter Zah and OSC Robert Bornstein informed the media of the response action and answered several questions. Following the press conference, the media was invited to the site for a tour. News reports and articles regarding EPA's actions appeared on local TV stations and newspapers including the Albuquerque Journal, Navajo Times, Grants Beacon and Gallup Independent.

Throughout the response action, OSC Bornstein assisted by the Navajo Superfund informed the local residents on the progress and success of the response actions. A grant was given to the Navajo Superfund Program from ATSDR to conduct further community relation activities to inform the general public of the hazards of old uranium mines.

Copies of the Administrative Record were sent to the libraries in Grants and Gallup, New Mexico.

E. RESOURCES COMMITTED

The Emergency Response Section incurred a total estimated cost of $332,565.00. Out of this amount, $233,901 is for extramural costs associated with the work conducted by Laguna Construction. The remaining costs are for TAT, REAC, ERT and EPA.

Table 2 outlines the cost breakdown to date. EPA Region IX is consulting with EPA HQ Office of Federal Affairs and the Department of Justice in pursuing the Department of the Interior with cost recovery.

Table 2. Estimated Project Cost Summary

Ceilings:	Site Total	$629,770.00
	Laguna Construction	$300,877.00
	TAT/REAC	$ 56,000.00
Extramural Costs:		
	Laguna Construction	$233,901.00
EPA Contract Costs		
	TAT - Ecology and Environment	$ 6,156.00
	REAC - Weston	$ 30,000.00
EPA/ERT Costs		
	EPA/ERT	$ 62,508.00
RESPONSE TOTAL TO DATE		$332,565.00

II. EFFECTIVENESS OF REMOVAL ACTION

The following response activities were completed by September 18, 1991:

* Filled, graded and applied an earth cover to areas emitting elevated gamma radiation;

* Filled, sealed and capped mine adits, inclines and shafts;

* Posted warning signs on site to advise people to not disturb reclaimed areas;

* Revegetated affected zones with natural grasses.

The National Council on Radiation Protection and Measurements (NCRP) Report 91 (1987) recommends the adoption of a limit for continuous or frequent exposure to radiation, at 100 mrem/yr effective dose equivalent (EDE) from all radiation sources (including external as well as internal sources but excluding natural background and medical exposures). The NCRP report also recommends that a limit of 500 mrem/yr be established for infrequent or "short term" exposure. In accordance with the above referenced NCRP guidelines, EPA's Office of Air and Radiation (OAR) has concurred with Region IX's Action Memorandum for the Bluewater Sites, which recommends that a limit of 100 mrem/yr of excess gamma radiation be adopted as a standard in this case.

Natural background gamma radiation from external sources in the vicinity of the Bluewater Uranium Mine Sites varies considerably and is dependent upon local geology. It may be as low as 12 uR/hr in areas lacking natural uranium deposits and as high as 20 uR/hr in areas containing uranium rich ore. Naturally exposed uranium rich Todilto limestone outcrops at the Desiderio Mine Site recorded readings as high as 50 uR/hr at waist level. For the purpose of this response action, EPA has estimated that the population in question (on average) spends two hours a day for 300 days/yr in the areas affected by mine operations. A more conservative estimate of 7 hours a day was given to EPA by the Navajo Superfund Program in May of 1991.

Navajo Superfund Program in May of 1991.

A. RESPONSE RESULTS

BROWN-VANDEVER-NANABAH SECTION 24

A 50 foot by 50 foot grid survey was conducted at the Brown-Vandever-Nanabah sites. The results of the post removal survey on Section 24, Township 13N, Range 10W of the Bluewater Quadrangle (Brown-Nanabah site) reveal that gamma radiation levels (once exceeding 500 uR/hr in places) have been drastically reduced (Figure 7). The average gamma reading within the reclaimed area is presently 28 uR/hr. The highest reading recorded within the survey was 56 uR/hr. In addition to reducing gamma radiation emissions, the covering of the protore and mine wastes most likely has reduced the surface radium and other radionuclide concentrations in the top 15 cm of soil (post analytical results are pending), as well as radon flux.

Using the average gamma reading, the population would receive a yearly excess gamma radiation dose of 7.8 mrem/yr. This compares to the average annual background radiation dose received in the United States of 300 mrem/yr as reported by the NCRP.

(28 uR/hr - 15 uR/hr) * 2 hours * 300 days/yr = 7800 uR/yr
7800 uR/yr = 7.8 mR/yr = 7.8 mrem/yr

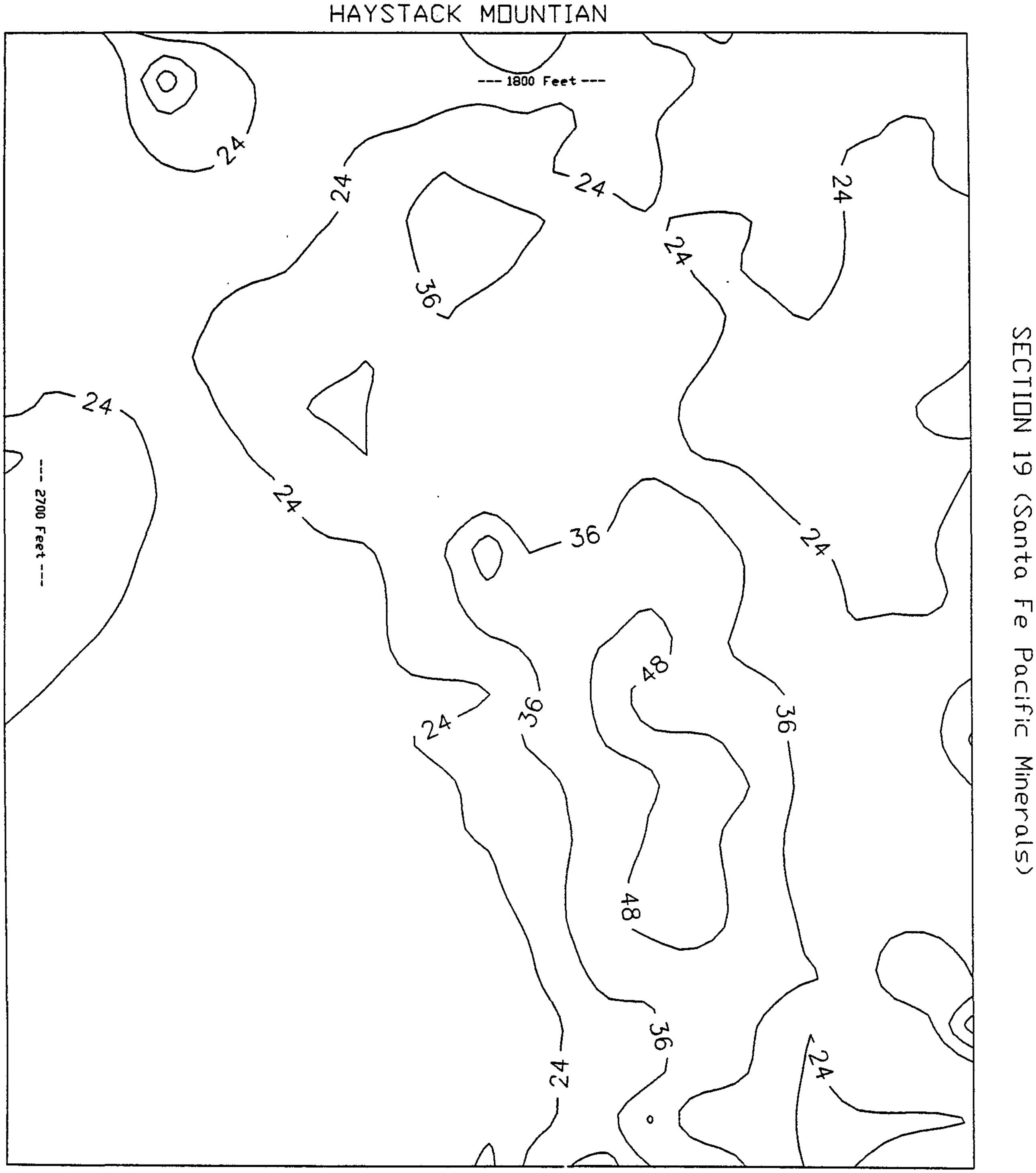
Using the conservative estimate of 7 hours a day and the average gamma reading for section 24, the excess gamma radiation for 300 days would be 27.3 mrem/year. This exposure is also well below the NCRP standards.

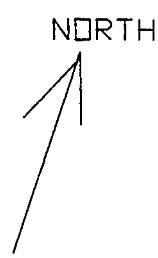
Therefore, in reclaimed areas, using EPA's estimations,

Figure 7.

POST RECLAMATION Nanabah Vandever

NANABAH ALLOTMENT (SEC. 24, T13N, R11W)





LEGEND

VALUES IN uR/Hr

Survey Conducted on 50' X 50' Grid

Waist Level Measurements

ERS Graphics 9/91

the population frequenting the site will not receive any significant excess gamma exposure. Their excess gamma exposures would not exceed the NCRP recommendation.

For frequent exposures (long term) the NCRP recommends populations to not exceed 100 mrem/yr EDE from all sources (excluding natural background and medical sources). With background being approximately 15 uR/hr in the affected area, populations could reside on areas of reclaimed land reading 27 uR/hr or less to adequately stay within this guideline (assuming they are not exposed to other excess radiation sources besides uranium chain gamma). Approximately 60% of the reclaimed land is potentially suitable for full time occupancy.

These are very conservative calculations because no credit is taken for the shielding effect of the home on any increases in terrestrial radiation. Additional studies should be conducted within the reclaimed area prior to allowing any homes to be built. However, it is highly unlikely that prior to mining operations, the gamma radiation levels presently being emitted were significantly lower. It is probable that some portions of the strip-mined area were naturally higher than the average background elsewhere as a result of the proximity to the surface of uranium-rich ore.

Therefore, the removal action appears to have effectively reduced the potential radiological hazards associated with the abandoned mine operations and has returned the land to a productive environment.

BROWN-VANDEVER SECTION 18

The post removal survey conducted on Section 18, Township 13N, Range 10W of the USGS Bluewater Quadrangle (the Brown Vandever site) revealed that the average gamma reading was 13 uR/hr. The highest reading was 29 uR/hr. This reading is essentially background and therefore, no additional action should be taken on this section (Figure 8).

DESIDERIO MINE SITE

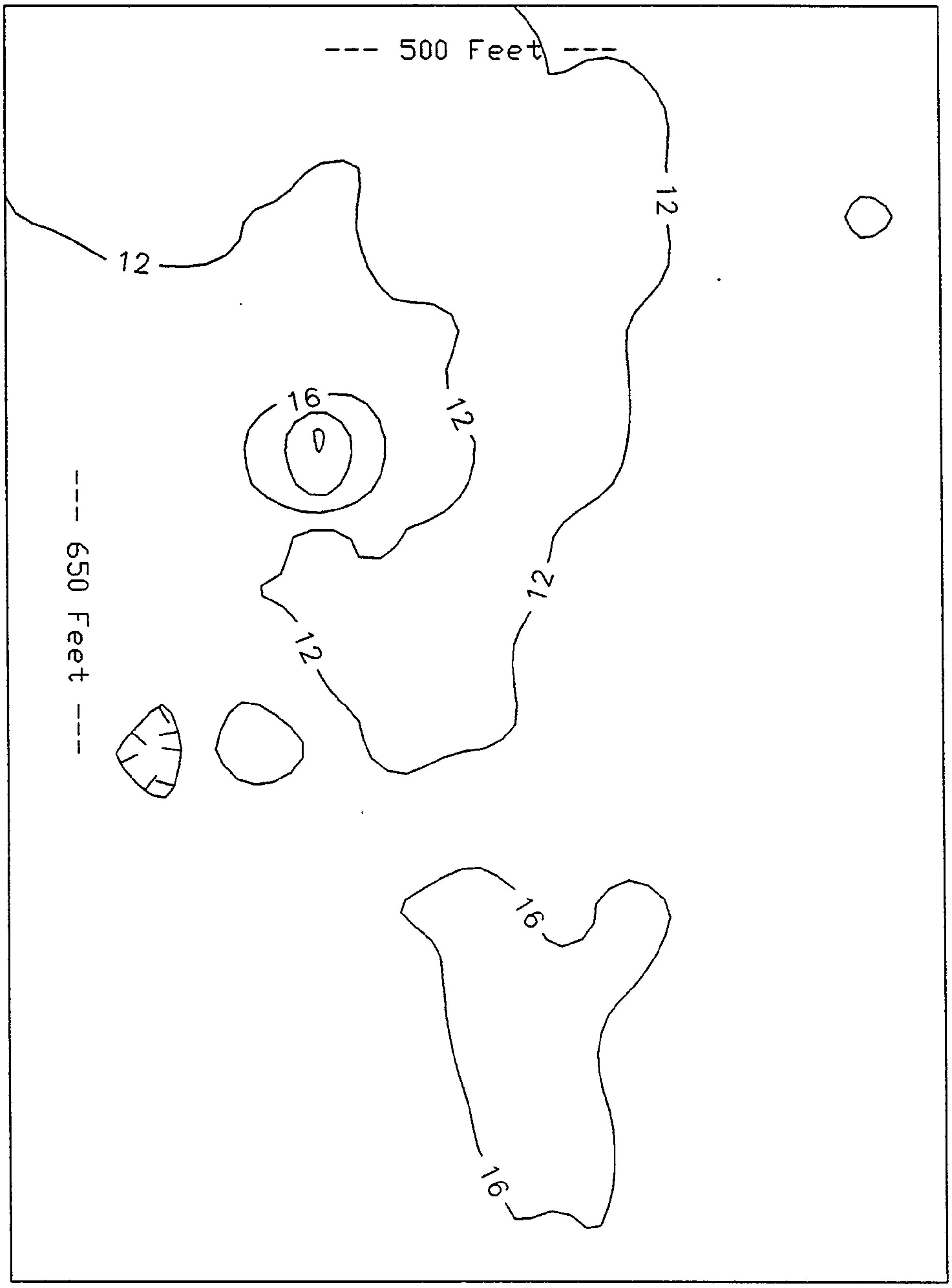
A post removal survey using a 100 foot by 100 foot grid was conducted on the top 15 acre portion (Starting at the residences and heading due east) at the Desiderio site (Section 26, Township 13N, Range 10W). This survey revealed that the average gamma reading within the reclamated area was 15 uR/hr . A random survey was conduct on the other reclamated areas near the road, the once far southern pits, and the old shaft areas. Values ranged from a high of 50 uR/hr to a low of 15 uR/hr. The average reading within these isolated locations was approximately 28 uR/hr.

Like the Vandever sections, the post removal results at the Desiderio site reveal that the gamma emissions (once exceeding 700 uR/hr in places) have been drastically reduced. Levels present at the site are well within reclamation guideline levels and pose no significant health risks for long term exposures. It is likely that the reclamated gamma emissions are no greater than those detected prior to mining operations at all three reclaimed

Figure 8.

POST RECLAMATION

BROWN-VANDEVER ALLOTMENT (SEC. 18, T13N, R10W)



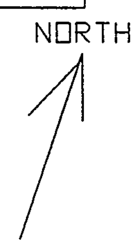
LEGEND

VALUES IN uR/Hr

Survey Conducted on 50′ X 50′ Grid

Waist Level Measurements

4 uR/Hr Contour Interval



ERS Graphics 9/91

sections (Readings of 50 uR/hr were detected on unmined naturally occurring Todilto limestone outcrops) (Figure 9).

On September 24, 1991, ATSDR concurred with EPA that the response action was satisfactory in eliminating the potential radiological hazards and protective of public health (See appendix C contains post response data, Appendix D, ATSDR letter).

B. ACTIONS TAKEN BY PRPs

Cerrillos Land Company conducted a gamma survey on Section 19 and at the advise of EPA, Cerrillos identified "hot" spots within the grid. Cerrillos Land Company, acting as the "lead" respondent, submitted a draft site stabilization plan to EPA on August 25, 1991. In addition, Cerrillos stated that it would comply with the Order. A revised plan was accepted by EPA on August 30, 1991 and Cerrillos mobilized its contractor, Taylor Excavation, on September 4, 1991.

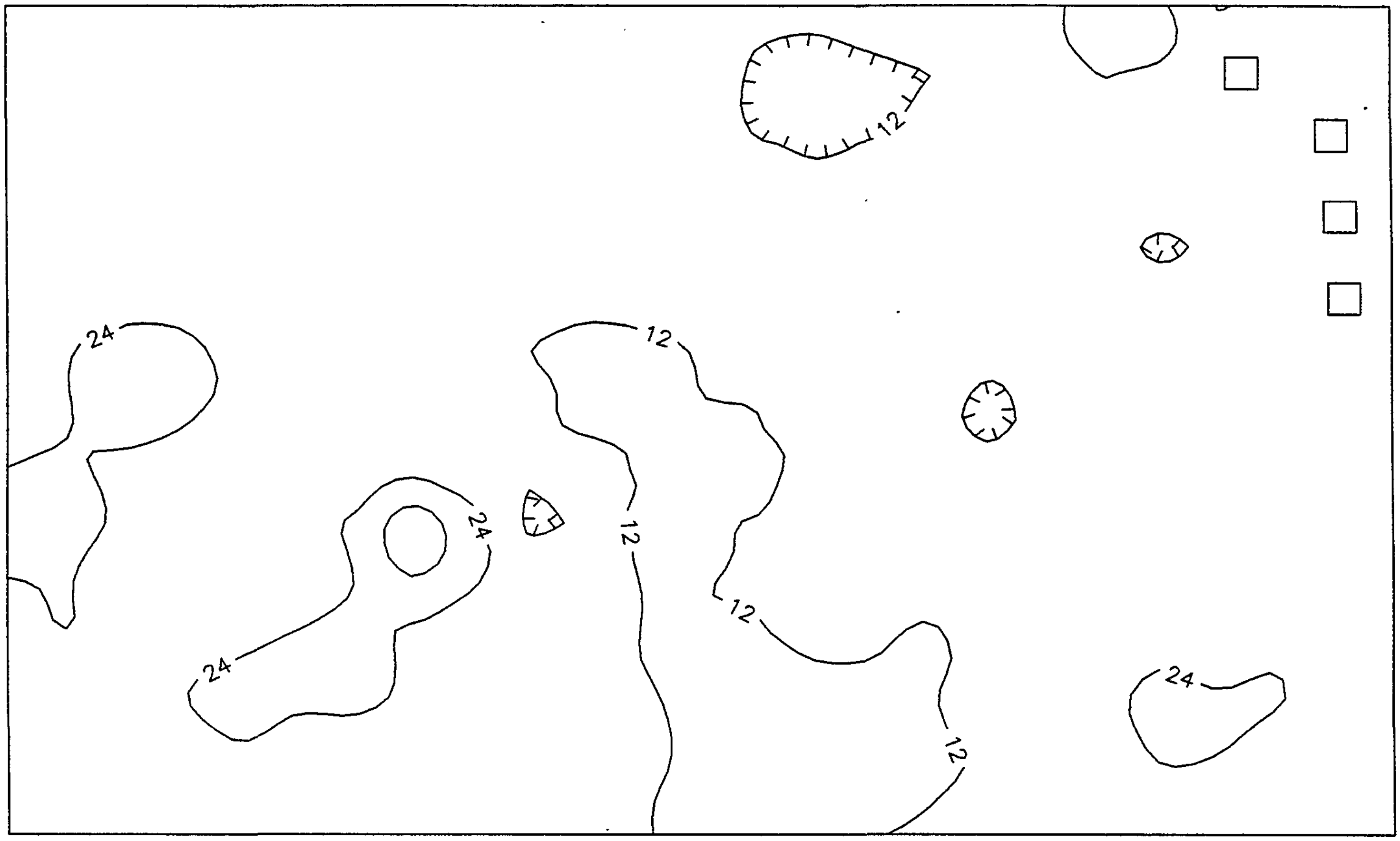
From September 4, 1991 to October 23, 1991, Taylor Excavation conducted earth moving activities on Section 19 to reduce the gamma radiation emissions to below 50 uR/hr.

C. ACTIONS BY STATE AND LOCAL AGENCIES

The Navajo Superfund Program identified the sites during 1990 as part of their Site Evaluation program. The Navajo Superfund Program played a vital and active role in pursuing a response action at the Sites. During the response action, the Navajo Superfund Program provided invaluable assistance and support throughout the response action. Members of the Navajo Superfund

Figure 9.

POST RECLAMATION
NAVAJO-DESIDERIO MINE SITE



LEGEND

VALUES IN uR/Hr

Survey Conducted on 100' X 100' Grid

Waist Level Measurements
100 uR/Hr Contour Interval

N

staff assisted EPA in conducting radiological surveys and public relations activities.

D. ACTIONS TAKEN BY FEDERAL AGENCIES

During the response activities, DOI and BIA representative were updated by EPA via pollution reports and correspondence. Copies of the post removal exposure summary report were sent to DOI, BLM, and DOI. The Grants BLM/NPS ranger station was utilized by EPA to distribute email pollution reports. Overall, BIA, BLM and DOI did not significantly contribute to the success of this response action.

DOE has informed EPA that it will pursue undertaking response activities on Section 13. DOE is presently trying to work with the mine lessee, George Warnock, in performing the required actions.

E. ACTIONS TAKEN BY CONTRACTORS

Three EPA contractors contributed to the success of the response action:

Ecology and Environment - TAT

- Conducted preliminary assessment and gamma survey support.

Weston - REAC

- Provided assistance in conducting pre and post gamma surveys.
- Provided site health physicist and radiological expertise.
- Conducted field photo documentation and assisted in data interpretations.
- Conducted air monitoring and assisted enforcing site safety plan.

Laguna Construction

- Conducted earth moving activities, sign posting and revegetation activities.

Weston REAC provided assistance throughout the removal action. Jerry Gils, REAC Health Physicist and project manager, provided outstanding field support in assisting in planning the response, conducting the extensive surveys and managing and interpreting site data.

Laguna Construction performed a superb job in reclamation. Gamma radiation readings and soil radionuclide concentrations were significantly reduced. Every aspect of the job went successfully. Mobilization was on time, maintenance and refueling of equipment went smoothly and the sign construction and placement was performed without any problems. Laguna Construction machine operators transformed the hummocky, scared topography back to "natural" conditions. Throughout the job, each tractor was meticulously cared for and maintained. At the conclusion of the job, no radioactive contamination was found on Laguna Construction equipment.

III. DIFFICULTIES ENCOUNTERED

A. ITEMS THAT AFFECTED THE RESPONSE

The Bluewater Uranium Mine response action was the first abandoned uranium mine emergency response action performed by Region IX. The action itself was a complete success in alleviating all of the potential radiological hazards noted by the

ATSDR Health Advisory.

The most difficult problem encountered on this project was determining if a response was warranted. Presently, EPA does not have any set guidance or action levels to respond to abandoned uranium mine sites. The data from the November 1990 assessment was distributed to ATSDR, OAR and IHS for review and comments. To accurately assess the data without actually spending time at the sites proved to be a difficult task. ATSDR concluded within its Health Advisory that the sites posed a significant health problem to the local population. However, the Advisory lacked data to substantiate its concerns (limited radiological data, no thorough exposure assessment, no analytical analysis). ATSDR and the Navajo Nation were convinced after reviewing the preliminary assessment data that a response action was warranted. However, after waiting several months for a response, OAR-HQ requested additional data from the sites before making a final determination. EPA Region IX decided that it would be prudent to conduct a response at the site since the assessment data did indicate elevated radiological readings and since a health advisory was issued concerning the site.

B. <u>ISSUES OF INTERGOVERNMENTAL COORDINATION</u>

Several interagency meetings were held to discuss the response actions at the sites. The Region IX Emergency Response Section (ERS) began an ongoing dialog with local and regional BIA, BLM, IHS, Navajo Nation, DOE and DOI representatives in order to ensure close coordination between all Federal Agencies regarding a response action at the Bluewater Sites. For several months, an effort to develop an IAG for the response action was undertaken by EPA and regional DOI representatives. Unfortunately, it appears that DOI and it's Bureaus failed to coordinate their actions. As a result of this miscommunication, EPA was unable to successfully enter into an agreement with DOI.

IV. RECOMMENDATIONS

To assist in responding and evaluating future uranium mine sites, the following recommendations should be implemented:

a) Thorough and complete gamma and radiological surveys should be completed on potential sites using a 50' by 50 ' grid to accurately assess radiological conditions.

ATSDR and earlier assessments noted extremely high gamma radiation readings. However, these extremely high gamma radiation readings were often anomalies rather than the norm.

b) After completing thorough gamma surveys, exposure assessments should be conducted. Accurate data on land use and population is required to adequate assess health risks.

In order to accurate assess the risk to human health from these mine sites, a complete and accurate risk assessment should be undertaken. The following critical questions must be accurately addressed:

How often and how long do people frequent the areas?
What uses are made of the land in question?

c) EPA and the BLM Office of Surface Mining (OSM) need to develop a joint strategy in addressing future mine sites.

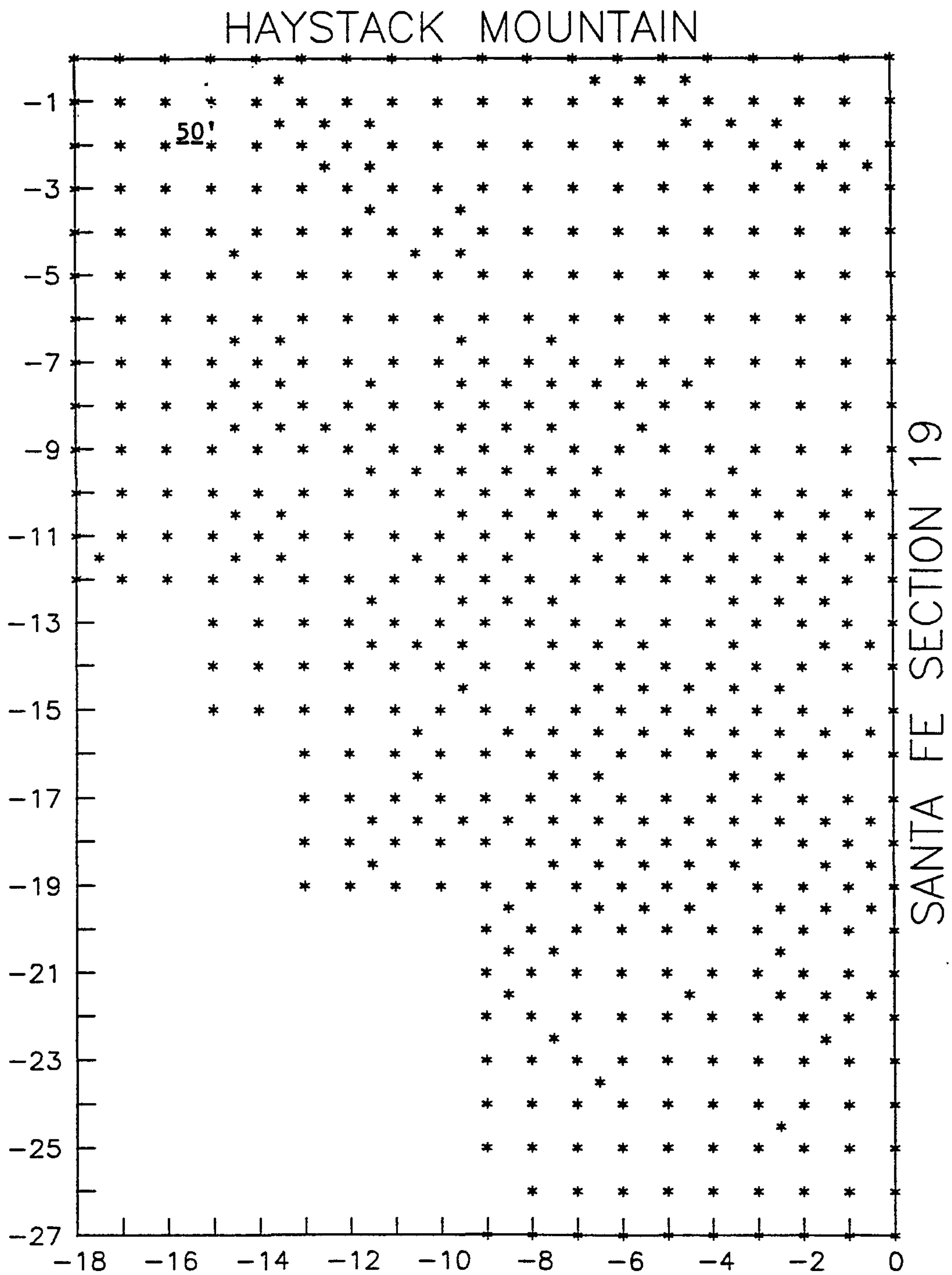
Presently, OSM is conducting mine reclamation activities under the authority of the Surface Mining Control and Reclamation Act (SMCRA). SMCRA applies to mines worked prior to August 3, 1977 and mines posing an imminent hazard to the public health and safety.

A Memorandum of Understanding should be developed between EPA and OSM agreeing that sites eligible for CERCLA actions should receive high prioritization for reclamation under SMCRA. In addition, BLM OSM should have enforcement powers to require responsible parties to undertake the required reclamation actions.

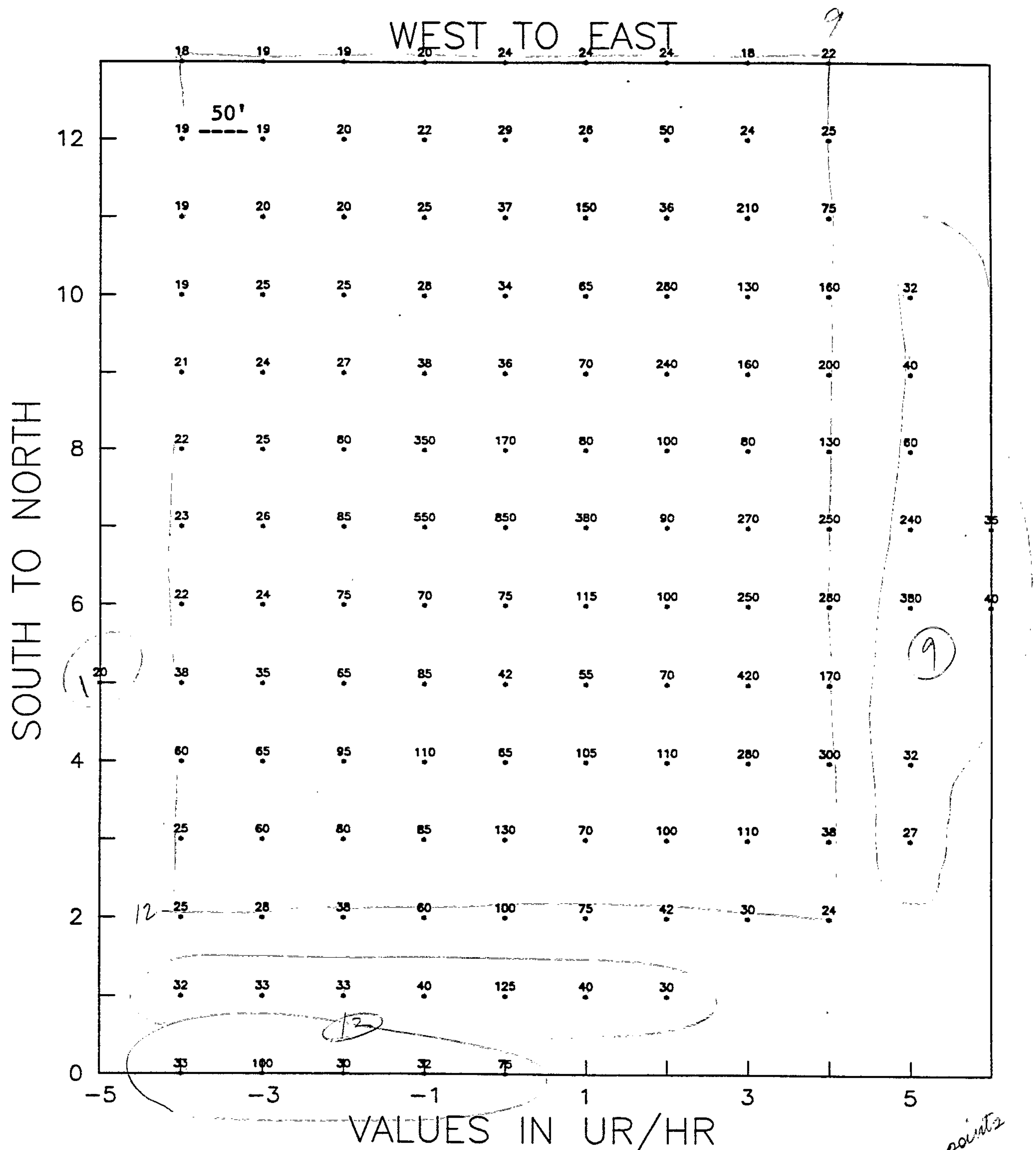
APPENDIX A

PRE-RECLAMATION GAMMA SURVEY DATA
AUGUST 11-19, 1991

SURVEY STATIONS (Sec. 24, T13N, R11W)

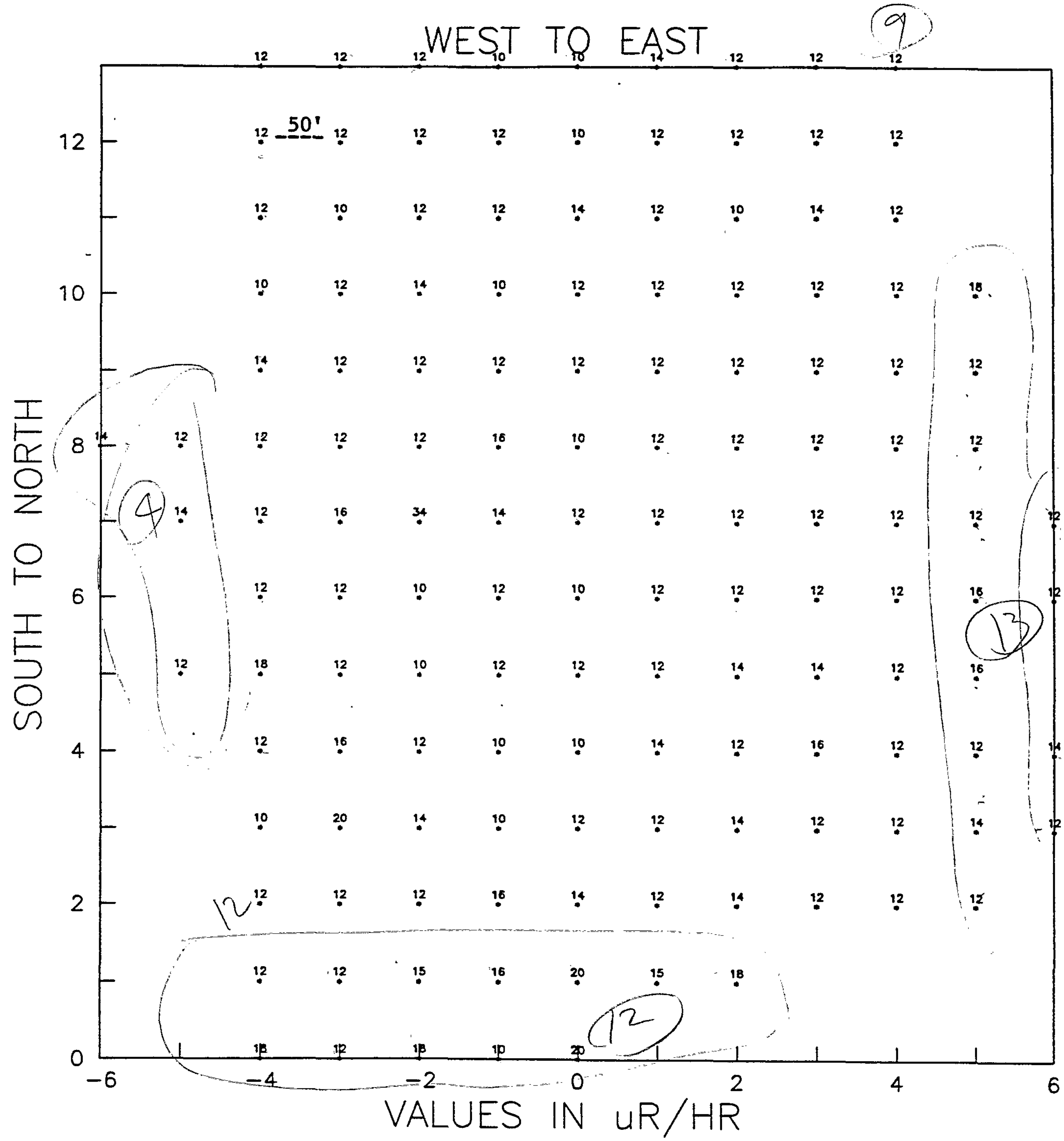


PRE RESPONSE (Sec. 18, T13N, R11W)

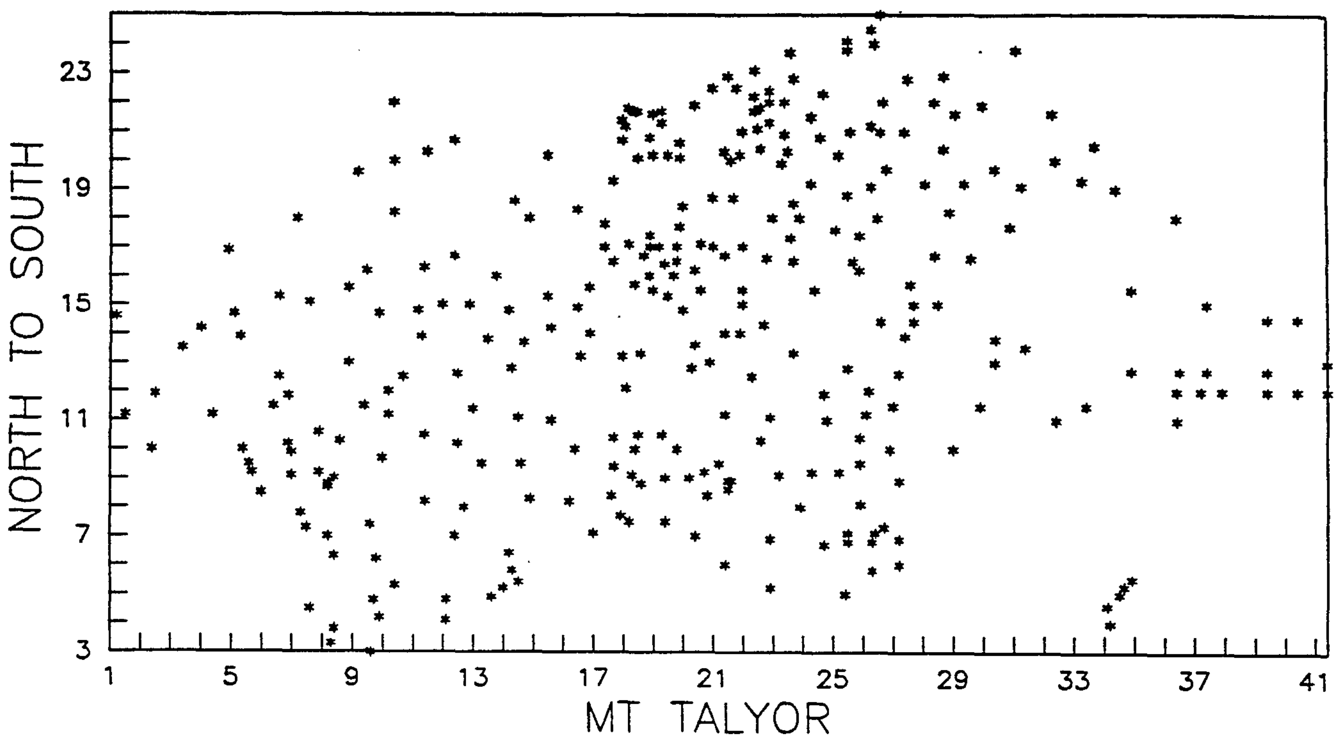


130 points

POST RESPONSE (Sec. 18, T13N, R11W)



NAVAJO–DESIDERIO MINE GAMMA STATIONS



Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
0	0	30	125
-1	0	20	20
-2	0	23	23
-3	0	19	21
-4	0	24	20
-5	0	24	48
-6	0	28	28
-7	0	68	70
-8	0	25	25
-9	0	23	23
-10	0	20	20
-11	0	25	28
-12	0	41	56
-13	0	28	23
-14	0	44	55
-15	0	33	33
-16	0	48	95
-17	0	33	35
-18	0	20	18
0	-1	23	24
-1	-1	20	22
-2	-1	22	22
-3	-1	24	25
-4	-1	65	35
-5	-1	100	85
-6	-1	50	55
-7	-1	25	22
-8	-1	27	32
-9	-1	29	29
-10	-1	24	23
-11	-1	24	25
-12	-1	65	60
-13	-1	31	27
-14	-1	65	65
-15	-1	27	26
-16	-1	50	60
-17	-1	36	40
-18	-1	23	21
0	-2	115	200
-1	-2	46	29
-2	-2	90	75
-3	-2	94	81
-4	-2	31	33
-5	-2	29	26
-6	-2	28	28
-7	-2	81	125
-8	-2	25	23
-9	-2	20	20
-10	-2	23	23
-11	-2	23	23

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-12	-2	75	94
-13	-2	40	38
-14	-2	55	45
-15	-2	38	38
-16	-2	28	23
-17	-2	20	19
-18	-2	18	16
0	-3	130	125
-1	-3	44	46
-2	-3	39	38
-3	-3	28	27
-4	-3	26	26
-5	-3	24	24
-6	-3	25	24
-7	-3	26	25
-8	-3	25	24
-9	-3	27	26
-10	-3	35	30
-11	-3	39	40
-12	-3	90	115
-13	-3	46	44
-14	-3	40	42
-15	-3	44	38
-16	-3	40	39
-17	-3	20	21
-18	-3	16	17
0	-4	33	31
-1	-4	30	26
-2	-4	29	29
-3	-4	31	31
-4	-4	31	35
-5	-4	35	33
-6	-4	25	25
-7	-4	28	28
-8	-4	30	30
-9	-4	29	29
-10	-4	31	31
-11	-4	54	54
-12	-4	90	95
-13	-4	65	65
-14	-4	155	230
-15	-4	30	29
-16	-4	25	25
-17	-4	18	18
-18	-4	18	18
0	-5	24	25
-1	-5	27	27
-2	-5	30	31
-3	-5	35	36
-4	-5	41	39

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	uR/hr Waist	uR/hr Ground
-5	-5	33	30
-6	-5	26	26
-7	-5	29	28
-8	-5	38	40
-9	-5	41	40
-10	-5	65	60
-11	-5	80	130
-12	-5	80	75
-13	-5	90	85
-14	-5	135	180
-15	-5	70	65
-16	-5	50	40
-17	-5	27	27
-18	-5	24	23
0	-6	36	31
-1	-6	33	29
-2	-6	80	90
-3	-6	46	44
-4	-6	33	30
-5	-6	28	28
-6	-6	31	31
-7	-6	34	35
-8	-6	31	31
-9	-6	30	30
-10	-6	75	75
-11	-6	100	140
-12	-6	95	120
-13	-6	80	90
-14	-6	95	95
-15	-6	90	90
-16	-6	36	34
-17	-6	29	28
-18	-6	20	21
0	-7	36	36
-1	-7	32	33
-2	-7	31	31
-3	-7	30	29
-4	-7	39	37
-5	-7	50	40
-6	-7	60	40
-7	-7	50	50
-8	-7	80	100
-9	-7	65	75
-10	-7	40	41
-11	-7	35	34
-12	-7	40	35
-13	-7	55	50
-14	-7	140	210
-15	-7	27	28
-16	-7	29	28

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-17	-7	30	30
-18	-7	25	26
0	-8	46	55
-1	-8	30	31
-2	-8	30	30
-3	-8	29	29
-4	-8	29	28
-5	-8	50	50
-6	-8	80	80
-7	-8	90	90
-8	-8	115	90
-9	-8	100	165
-10	-8	35	35
-11	-8	45	45
-12	-8	39	38
-13	-8	150	150
-14	-8	33	31
-15	-8	50	56
-16	-8	25	28
-17	-8	35	28
-18	-8	31	38
0	-9	32	41
-1	-9	35	34
-2	-9	34	34
-3	-9	32	31
-4	-9	31	30
-5	-9	33	32
-6	-9	40	38
-7	-9	30	60
-8	-9	125	165
-9	-9	100	90
-10	-9	50	39
-11	-9	65	60
-12	-9	95	120
-13	-9	80	85
-14	-9	65	70
-15	-9	45	35
-16	-9	50	45
-17	-9	60	60
-18	-9	55	55
0	-10	36	36
-1	-10	38	36
-2	-10	35	35
-3	-10	40	33
-4	-10	95	75
-5	-10	36	36
-6	-10	39	29
-7	-10	44	46
-8	-10	90	90
-9	-10	95	90

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-10	-10	65	50
-11	-10	75	95
-12	-10	40	31
-13	-10	100	115
-14	-10	40	40
-15	-10	29	29
-16	-10	25	23
-17	-10	48	60
-18	-10	45	60
0	-11	45	40
-1	-11	60	50
-2	-11	45	40
-3	-11	65	50
-4	-11	90	90
-5	-11	60	55
-6	-11	60	55
-7	-11	125	155
-8	-11	65	50
-9	-11	90	80
-10	-11	130	130
-11	-11	65	65
-12	-11	33	33
-13	-11	29	29
-14	-11	230	275
-15	-11	22	22
-16	-11	20	20
-17	-11	20	19
-18	-11	18	19
0	-12	39	39
-1	-12	46	46
-2	-12	46	34
-3	-12	114	93
-4	-12	200	214
-5	-12	171	200
-6	-12	93	86
-7	-12	114	129
-8	-12	49	43
-9	-12	186	171
-10	-12	214	243
-11	-12	86	57
-12	-12	31	29
-13	-12	29	26
-14	-12	26	23
-15	-12	19	17
-16	-12	17	17
-17	-12	17	17
-18	-12	14	14
0	-13	39	40
-1	-13	65	55
-2	-13	45	50

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-3	-13	150	700
-4	-13	110	90
-5	-13	190	200
-6	-13	175	200
-7	-13	95	90
-8	-13	85	75
-9	-13	190	185
-10	-13	110	115
-11	-13	30	29
-12	-13	29	29
-13	-13	22	22
-14	-13	20	20
-15	-13	19	19
0	-14	100	86
-1	-14	46	49
-2	-14	100	86
-3	-14	100	86
-4	-14	171	143
-5	-14	314	229
-6	-14	271	214
-7	-14	171	164
-8	-14	60	51
-9	-14	143	157
-10	-14	46	51
-11	-14	171	214
-12	-14	29	29
-13	-14	23	23
-14	-14	20	20
-15	-14	20	20
0	-15	75	75
-1	-15	55	50
-2	-15	65	75
-3	-15	85	85
-4	-15	165	165
-5	-15	160	155
-6	-15	145	140
-7	-15	84	86
-8	-15	47	42
-9	-15	46	40
-10	-15	38	34
-11	-15	28	48
-12	-15	22	22
-13	-15	20	20
-14	-15	18	18
-15	-15	18	18
0	-16	86	86
-1	-16	54	50
-2	-16	100	114
-3	-16	171	264
-4	-16	200	229

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-5	-16	114	93
-6	-16	107	114
-7	-16	171	200
-8	-16	79	54
-9	-16	40	36
-10	-16	40	40
-11	-16	46	34
-12	-16	29	23
-13	-16	20	20
0	-17	38	39
-1	-17	70	110
-2	-17	95	80
-3	-17	100	115
-4	-17	70	55
-5	-17	85	85
-6	-17	135	150
-7	-17	100	85
-8	-17	50	50
-9	-17	55	55
-10	-17	50	50
-11	-17	39	31
-12	-17	23	21
-13	-17	18	18
0	-18	40	40
-1	-18	100	86
-2	-18	214	257
-3	-18	371	600
-4	-18	100	93
-5	-18	100	93
-6	-18	157	171
-7	-18	271	286
-8	-18	57	50
-9	-18	37	31
-10	-18	40	49
-11	-18	114	100
-12	-18	29	23
-13	-18	20	19
0	-19	38	38
-1	-19	125	130
-2	-19	100	90
-3	-19	95	90
-4	-19	65	65
-5	-19	65	70
-6	-19	125	125
-7	-19	85	105
-8	-19	85	100
-9	-19	31	30
-10	-19	28	28
-11	-19	25	24
-12	-19	22	23

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-13	-19	19	19
0	-20	100	86
-1	-20	129	207
-2	-20	129	150
-3	-20	86	79
-4	-20	100	86
-5	-20	86	71
-6	-20	20	19
-7	-20	114	114
-8	-20	54	60
-9	-20	29	29
0	-21	70	55
-1	-21	80	120
-2	-21	110	115
-3	-21	70	65
-4	-21	44	46
-5	-21	65	65
-6	-21	90	85
-7	-21	48	46
-8	-21	60	60
-9	-21	27	25
0	-22	36	31
-1	-22	49	40
-2	-22	57	100
-3	-22	46	51
-4	-22	31	29
-5	-22	93	157
-6	-22	37	34
-7	-22	40	37
-8	-22	107	93
-9	-22	29	26
0	-23	37	34
-1	-23	35	34
-2	-23	30	29
-3	-23	30	30
-4	-23	29	28
-5	-23	55	50
-6	-23	45	38
-7	-23	75	135
-8	-23	29	31
-9	-23	25	24
0	-24	37	34
-1	-24	29	26
-2	-24	29	27
-3	-24	46	46
-4	-24	51	37
-5	-24	31	31
-6	-24	34	31
-7	-24	34	29
-8	-24	20	20

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-9	-24	21	20
0	-25	26	26
-1	-25	27	28
-2	-25	26	24
-3	-25	30	32
-4	-25	27	26
-5	-25	23	21
-6	-25	21	20
-7	-25	22	21
-8	-25	19	17
-9	-25	16	15
0	-26	23	23
-1	-26	23	23
-2	-26	23	23
-3	-26	23	23
-4	-26	23	23
-5	-26	20	20
-6	-26	20	20
-7	-26	20	17
-8	-26	14	14
	-26	14	14
0	-27	20	19
-1	-27	21	20
-2	-27	22	21
-3	-27	25	23
-4	-27	22	22
-5	-27	23	23
-6	-27	21	22
-7	-27	20	18
-8	-27	33	22
-9	-27	15	14
-4.5	-0.5	86	60
-5.5	-0.5	86	60
-6.5	-0.5	86	60
-13.5	-0.5	71	50
-2.5	-1.5	114	80
-3.5	-1.5	114	80
-4.5	-1.5	129	90
-11.5	-1.5	100	70
-12.5	-1.5	114	80
-13.5	-1.5	71	50
-0.5	-2.5	157	110
-1.5	-2.5	100	70
-2.5	-2.5	114	80
-11.5	-2.5	100	70
-12.5	-2.5	107	75
-9.5	-3.5	86	60
-11.5	-3.5	100	70
-9.5	-4.5	86	60
-10.5	-4.5	100	70

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	uR/hr Waist	uR/hr Ground
-14.5	-4.5	157	110
-7.5	-6.5	57	40
-9.5	-6.5	43	30
-13.5	-6.5	86	60
-14.5	-6.5	100	70
-4.5	-7.5	79	55
-5.5	-7.5	79	55
-6.5	-7.5	114	80
-7.5	-7.5	157	110
-8.5	-7.5	100	70
-9.5	-7.5	71	50
-11.5	-7.5	57	40
-13.5	-7.5	100	70
-14.5	-7.5	57	40
-5.5	-8.5	79	55
-7.5	-8.5	121	85
-8.5	-8.5	129	90
-9.5	-8.5	57	40
-11.5	-8.5	86	60
-12.5	-8.5	100	70
-13.5	-8.5	57	40
-14.5	-8.5	43	30
-3.5	-9.5	71	50
-6.5	-9.5	50	35
-7.5	-9.5	50	35
-8.5	-9.5	121	85
-9.5	-9.5	46	32
-10.5	-9.5	71	50
-11.5	-9.5	86	60
-0.5	-10.5	100	70
-1.5	-10.5	100	70
-2.5	-10.5	71	50
-3.5	-10.5	93	65
-4.5	-10.5	57	40
-5.5	-10.5	43	30
-6.5	-10.5	114	80
-7.5	-10.5	143	100
-8.5	-10.5	129	90
-9.5	-10.5	114	80
-13.5	-10.5	286	200
-14.5	-10.5	286	200
-0.5	-11.5	43	30
-1.5	-11.5	57	40
-2.5	-11.5	129	90
-3.5	-11.5	186	130
-4.5	-11.5	71	50
-5.5	-11.5	57	40
-6.5	-11.5	50	35
-8.5	-11.5	129	90
-9.5	-11.5	164	115

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	uR/hr Waist	uR/hr Ground
-10.5	-11.5	71	50
-13.5	-11.5	286	200
-14.5	-11.5	286	200
-17.5	-11.5	57	40
-1.5	-12.5	57	40
-2.5	-12.5	186	130
-3.5	-12.5	154	108
-7.5	-12.5	143	100
-8.5	-12.5	171	120
-9.5	-12.5	164	115
-11.5	-12.5	57	40
-0.5	-13.5	43	30
-1.5	-13.5	179	125
-3.5	-13.5	171	120
-5.5	-13.5	186	130
-6.5	-13.5	371	260
-7.5	-13.5	371	260
-9.5	-13.5	93	65
-10.5	-13.5	114	80
-11.5	-13.5	100	70
-2.5	-14.5	243	170
-3.5	-14.5	200	140
-4.5	-14.5	229	160
-5.5	-14.5	271	190
-6.5	-14.5	171	120
-9.5	-14.5	114	80
-0.5	-15.5	1714	1200
-1.5	-15.5	514	360
-2.5	-15.5	486	340
-3.5	-15.5	314	220
-4.5	-15.5	286	200
-5.5	-15.5	343	240
-6.5	-15.5	857	600
-7.5	-15.5	243	170
-8.5	-15.5	186	130
-10.5	-15.5	514	360
-2.5	-16.5	240	
-3.5	-16.5	410	
-6.5	-16.5	750	
-7.5	-16.5	175	
-10.5	-16.5	300	
-0.5	-17.5	714	500
-1.5	-17.5	714	500
-2.5	-17.5	343	240
-3.5	-17.5	1429	1000
-4.5	-17.5	186	130
-5.5	-17.5	1143	800
-6.5	-17.5	536	375
-7.5	-17.5	286	200
-8.5	-17.5	314	220

Nanabah-Vandever Site, Section 24
Pre-Remediation Survey, August, 1991

West	South	Waist (uR/hr)	Ground (uR/hr)
-9.5	-17.5	286	200
-10.5	-17.5	286	200
-11.5	-17.5	500	350
-0.5	-18.5	430	
-1.5	-18.5	250	
-3.5	-18.5	2300	
-4.5	-18.5	900	
-5.5	-18.5	850	
-6.5	-18.5	1000	
-7.5	-18.5	1200	
-11.5	-18.5	210	
-0.5	-19.5	429	300
-1.5	-19.5	857	600
-2.5	-19.5	371	260
-4.5	-19.5	200	140
-5.5	-19.5	1357	950
-6.5	-19.5	357	250
-8.5	-19.5	286	200
-2.5	-20.5	175	
-7.5	-20.5	210	
-8.5	-20.5	1000	
-0.5	-21.5	600	420
-1.5	-21.5	1429	1000
-2.5	-21.5	200	140
-4.5	-21.5	186	130
-8.5	-21.5	257	180
-1.5	-22.5	950	
-7.5	-22.5	1700	
-6.5	-23.5	514	360
-2.5	-24.5	125	

Avg Gamma 118.16 uR/hr

Brown-Vandever Site, Section 18
Pre-Remediation Survey, August, 1991

West	North	Waist (uR/hr)	Ground (uR/hr)
-4	0	33	26
-3	0	100	120
-2	0	30	32
-1	0	32	31
0	0	75	60
-4	1	32	27
-3	1	33	32
-2	1	33	32
-1	1	40	42
0	1	125	120
1	1	40	40
2	1	30	26
-4	2	25	25
-3	2	28	28
-2	2	38	35
-1	2	60	55
0	2	100	145
1	2	75	60
2	2	42	44
3	2	30	27
4	2	24	24
-4	3	25	25
-3	3	60	60
-2	3	80	115
-1	3	85	75
0	3	130	140
1	3	70	60
2	3	100	110
3	3	110	85
4	3	38	28
5	3	27	25
-4	4	60	75
-3	4	65	75
-2	4	95	100
-1	4	110	125
0	4	65	50
1	4	105	105
2	4	110	120
3	4	280	350
4	4	300	370
5	4	32	32
-4	5	38	29
-3	5	35	38
-2	5	65	55
-1	5	85	75
0	5	42	42
1	5	55	55
2	5	70	70
3	5	420	600
4	5	170	80

Brown-Vandever Site, Section 18
Pre-Remediation Survey, August, 1991

West	North	Waist (uR/hr)	Ground (uR/hr)
-4	6	22	21
-3	6	24	25
-2	6	75	65
-1	6	70	105
0	6	75	70
1	6	115	120
2	6	100	115
3	6	250	240
4	6	280	300
5	6	380	500
-4	7	23	23
-3	7	26	26
-2	7	85	85
-1	7	550	600
0	7	850	800
1	7	380	450
2	7	90	95
3	7	270	290
4	7	250	330
5	7	240	250
-4	8	22	21
-3	8	25	26
-2	8	80	75
-1	8	350	380
0	8	170	125
1	8	80	65
2	8	100	115
3	8	80	80
4	8	130	100
5	8	60	50
-4	9	21	21
-3	9	24	25
-2	9	27	26
-1	9	38	39
0	9	36	38
1	9	70	90
2	9	240	300
3	9	160	220
4	9	200	200
5	9	40	36
-4	10	19	19
-3	10	25	24
-2	10	25	23
-1	10	28	28
0	10	34	33
1	10	65	50
2	10	280	350
3	10	130	130
4	10	160	170
5	10	32	32

Brown-Vandever Site, Section 18
Pre-Remediation Survey, August, 1991

West	North	Waist (uR/hr)	Ground (uR/hr)
-4	11	19	19
-3	11	20	20
-2	11	20	20
-1	11	25	25
0	11	37	36
1	11	150	160
2	11	36	30
3	11	210	250
4	11	75	50
-4	12	19	18
-3	12	19	19
-2	12	20	20
-1	12	22	23
0	12	29	27
1	12	26	25
2	12	50	50
3	12	24	24
4	12	25	24
-4	13	18	17
-3	13	19	19
-2	13	19	18
-1	13	20	19
0	13	24	22
1	13	24	22
2	13	24	20
3	13	18	16
4	13	22	20
6	6	40	32
6	7	35	30
-5	5	20	21

Avg Gamma 92.05 uR/hr

Desiderio Site
Pre-Remediation Survey, August, 1991

South	West	Waist (uR/hr)	Ground (uR/hr)
19	34	30	50
18	36	20	30
15.5	34.5	10	10
15	37	30	
14.5	39	100	200
14.5	40	10	20
13	41	200	500
12	41	200	400
5.5	34.5	200	380
5.25	34.25	200	400
5	34.1	300	500
4.6	33.7	300	500
4	33.8	500	800
11	36	10	50
12	36	500	500
12	36.8	170	200
12	37.5	250	600
12	39	310	1000
12	40	40	48
12.7	39	110	250
12.7	37	180	400
12.7	36.1	130	110
12.7	34.5	310	380
13.5	31	100	130
13	30	100	110
13.8	30	80	80
11.5	29.5	130	130
11	32	250	800
11.5	33	110	110
10	28.6	300	1500
6	26.8	250	500
6.9	26.8	400	3000
7.3	26.3	300	300
6.8	25.9	50	50
5.8	25.9	30	30
5	25	25	25
5.2	22.5	28	28
6	21	20	20
7	20	30	30
7.5	19	32	32
9	19	120	300
9.1	17.9	50	50
10	18	50	50
10.5	18.1	100	800
10.5	18.9	50	50
10	19.4	35	35
9.2	20.3	35	35
9	19.8	30	30
8.4	20.4	30	30
8.6	21.1	38	38

Desiderio Site
Pre-Remediation Survey, August, 1991

South	West	uR/hr Waist	Ground
6.9	22.5	30	30
6.7	24.3	50	50
6.8	25.1	80	80
7.1	25.1	110	170
11.1	22.5	100	100
11.2	21	150	150
12.8	19.9	100	100
13.3	18.2	110	110
16.2	25.5	100	300
16.5	25.3	350	
15.5	24		150
16.5	23.3	350	
14.3	22.3	35	35
14	21.5	50	50
13.3	23.3	100	100
14	21	50	50
12.5	21.9	75	75
13	20.5	135	140
13.6	20	65	65
14	16.5	600	2000
7.7	17.5	24	24
5.4	14.1	35	35
5.8	13.9	50	70
5.2	13.6	35	35
4.9	13.2	35	35
4.1	11.7	28	28
4.8	11.7	25	25
3	9.2	60	500
3.3	7.9	40	70
3.8	8	60	100
4.2	9.5	35	35
4.5	7.2	35	35
7.3	7.1	50	50
7.8	6.9	50	400
8.5	5.6	35	35
9.2	5.3	40	75
9.5	5.2	50	50
10	5	65	750
11.5	6	30	30
11.85	6.5	75	300
9.9	6.6	45	45
9.2	7.5	50	50
8.7	7.8	75	75
7	7.8	45	45
6.3	8	35	35
7.4	9.2	50	50
6.2	9.4	50	50
5.3	10	130	1000
4.8	9.3	35	35
25	26.2	23	

Desiderio Site
Pre-Remediation Survey, August, 1991

		uR/hr	
South	West	Waist	Ground
24.5	25.9	23	
24	26	29	
23.8	25.1	36	
24.1	25.1	43	
21.2	25.9	86	
19.1	25.9	43	
18	26.1	107	
17.4	25.5	129	
17.6	24.7	200	
18.8	25.1	114	
17.3	23.2	43	
20.2	24.8	100	
20.8	24.2	100	
21.5	23.9	40	
22.8	23.3	43	
22.4	22.5	107	
22	22.5	157	
21.3	22.5	171	
22	23	157	
20.9	23	34	
21.1	22.1	114	
21.7	22	114	
22.2	22	129	
23.1	22	71	
23.7	23.2	21	
22.9	21.1	114	
22.5	21.4	171	
21.8	22.2	157	
21	21.6	86	
20.4	22.2	34	
20.3	23.1	34	
19.9	22.9	34	
19.2	23.9	37	
18.5	23.3	34	
18	22.6	34	
18	23.5	34	
21	25.2	43	
22.3	24.3	46	
22.5	20.6	31	
20.3	21	143	
20.2	21.5	157	
20	21.2	31	
18.7	21.3	29	
17	21.6	40	
16.6	22.4	57	
15.5	21.6	343	
15	21.6	86	
16.7	21	86	
17	20.6	186	
17.1	20.2	214	

Desiderio Site
Pre-Remediation Survey, August, 1991

		uR/hr	
South	West	Waist	Ground
17	19.4	157	
17.7	19.5	37	
18.7	20.6	29	
18.4	19.6	31	
19.3	17.3	29	
20.1	18.1	114	
20.2	18.6	200	
20.8	18.5	314	
21.3	18.9	271	
20.2	19.1	286	
20.6	19.5	143	
20.1	19.5	143	
21.6	18.6	236	
21.2	17.7	300	
20.7	17.6	200	
21.7	18.1	200	
21.4	17.6	214	
21.7	18	157	
21.8	17.8	26	
21.7	18.9	193	
21.9	20	26	
20.2	15.1	26	
18.6	14	49	
18	14.5	100	
18.3	16.1	29	
17.8	17	46	
17.4	18.5	186	
17	18.8	157	
16.7	18.3	143	
17	18.5	143	
17.1	17.8	329	
16.5	17.3	171	
16	18.5	343	
15.7	18	314	
15.5	18.6	214	
15.3	19.1	214	
16.4	19	186	
16.5	19.4	214	
16	19.3	214	
16.2	20	229	
15.5	20.2	221	
14.8	19.6	214	
17	17	129	
15.6	16.5	357	
14.9	16.1	629	
15.3	15.1	1143	
14.8	13.8	429	
16	13.4	1000	
16.7	12	429	
14.2	15.2	71	

Desiderio Site
Pre-Remediation Survey, August, 1991

South	West	Waist (uR/hr)	Ground (uR/hr)
15	12.5	314	
15	11.6	100	
14.8	10.8	314	
16.3	11	571	
18.2	10	37	
19.6	8.8	300	
20	10	286	
20.3	11.1	186	
20.7	12	214	
22	10	21	
18	6.8	26	
16.9	4.5	24	
15.3	6.2	100	
15.1	7.2	157	
16.2	9.1	51	
15.6	8.5	214	
14.7	9.5	66	
12.5	6.2	31	
13.9	4.9	129	
14.7	4.7	200	
14.2	3.6	114	
11.2	4	57	
11.9	2.1	86	
13.5	3	121	
11.2	1.1	64	
13	0.6	37	
14.6	0.8	23	
10	2	30	
9.3	0.6	23	
23.8	30.7	21	21
22.9	28.3	29	29
22	28	43	43
21.6	28.7	43	57
21.9	29.6	21	21
21.6	31.9	43	43
20	32	29	29
19.7	30	71	71
20.4	28.3	143	371
21	27	257	371
22.8	27.1	71	71
22	26.3	100	186
21	26.2	171	329
19.7	26.4	71	71
19.2	27.7	34	34
19.2	29	43	26
19.1	30.9	29	29
19.3	32.9	29	31
20.5	33.3	20	20
17.7	30.5	29	26
16.6	29.2	29	34

Desiderio Site
Pre-Remediation Survey, August, 1991

South	West	uR/hr Waist	Ground
18.2	28.5	29	29
16.7	28	26	26
15	28.1	46	40
14.4	27.3	43	37
13.9	27	71	71
14.4	26.2	54	57
15.7	27.2	69	46
15	27.3	97	114
12.6	26.8	214	457
12.8	25.1	71	71
12	25.8	43	34
11.2	25.7	71	71
11.5	26.6	143	143
11.9	24.3	46	40
10.4	25.5	214	429
9.5	25.5	143	186
10	26.5	186	214
7.1	26	200	171
8.9	26.8	86	71
9.2	24.8	214	171
11	24.4	457	2857
8.1	25.5	43	43
9.1	22.8	100	71
8.9	21.2	37	29
10.3	22.2	71	86
9.5	20.8	57	54
8.9	21.1	37	40
8	23.5	43	43
9.2	23.9	57	51
13.7	14.3	46	46
13.2	16.2	63	57
13.2	17.6	257	857
12.1	17.7	71	71
10.4	17.3	34	29
9.4	17.3	34	31
8.8	18.2	36	31
7.5	17.8	36	31
7.1	16.6	21	21
8.4	17.2	23	23
8.2	15.8	26	26
8.3	14.5	31	29
9.5	14.2	43	29
10	16	29	29
11	15.2	34	31
11.1	14.1	43	31
11.4	12.6	37	29
12.6	12.1	43	36
12.8	13.9	36	31
13.8	13.1	143	286
13.9	10.9	37	40

Desiderio Site
Pre-Remediation Survey, August, 1991

South	West	Waist (uR/hr)	Ground (uR/hr)
12	9.8	66	79
11.5	9	186	371
10.3	8.2	57	36
9.7	9.6	143	100
8.2	11	257	257
8	12.3	286	514
7	12	343	457
6.4	13.8	34	34
9.5	12.9	243	286
10.2	12.1	429	543
10.5	11	229	157
11.2	9.8	51	34
12.5	10.3	36	34
13	8.5	86	200
10.6	7.5	49	39
9	8	429	3429
8.8	7.8	100	321
9.1	6.6	71	86
10.2	6.5	57	49

Avg Gamma 122.93 uR/hr

APPENDIX B

DUST GENERATION SUMMARY DURING RECLAMATION ACTION

Aerosol Particulate Monitoring at the Bluewater Uranium Mine Site

EPA Region IX, assisted by EPA/ERT and REAC is conducting a removal action at several areas of the Vandever and Desiderio mine sites near Prewitt, NM. As a result of earth moving operations to cover certain strip-mined areas, the potential exists for resuspension of higher than ambient concentrations of uranium and/or radium. From analysis of previous samples taken at these sites, using the maximum detected concentrations of each isotope, it was calculated that, for Class W lung retention and a 60 hour work week, a dust concentration of 170 micrograms per liter (ug/L) would result in a dose of 100 millirem per week (mrem/wk). In order to protect the workers, a criterion of "visible dust" was established for Level C respiratory protection. If "visible dust" (or, about 10 ug/L) is present, all unprotected personnel must go to Level C respiratory protection.

In order to better quantify dust concentrations present at locations of interest, a model RAM-1 real-time aerosol monitor was used. This instrument, S/N 1727, calibrated at REAC on 7/28/91, was manufactured by MIE (Monitoring Instruments for the Environment, Inc.) of Bedford, Massachusetts. The RAM-1 is a portable, self-contained aerosol monitor whose sensing principle is based on the detection of near-forward scattered infrared radiation. The instrument uses a gallium arsenide semiconductor which generates EM radiation at 940 nanometers (nm) wavelength. The scattered radiation is detected by means of a silicon photo-voltaic type diode with an integral low-noise preamplifier. The instrument has three selectable ranges [0-2, 0-20, and 0-200 mg/m^3 (= ug/L)]. In addition, there are four operator-selectable response-time constants (0.5, 2, 8 and 32 seconds). The air flow-rate for sampling is 2 L/min, and for flushing with clean air is 0.2 L/min. After being fully charged, the instrument is designed to operate continuously for 6 to 8 hours.

The following table summarizes aerosol particulate data obtained at the Brown Vandever site (beginning 8/20/91), and at the Desiderio site (beginning 9/3/91).

The response time constant for the measurements was usually 2 seconds. With the exception of the time a car passed within 4 feet of the instrument, the maximum airborne dust concentration measured was 0.371 ug/L. If breathed at that concentration continuously (60 hours per week) for a year with the maximum concentrations previously measured of uranium and radium, a 50-year committed effective dose equivalent (cede) of 10.9 mrem would result.

$$[\text{cede} = (5000/170) \times (C_{max}) = 29.41\ C_{max}]$$

$$\text{cede}_{50\ yr}\ (\text{mrem}) = 29.41\ C_{max}\ (\text{ug/L})$$

where,

$$C_{max} = \text{Dust Concentration in ug/L}$$

Over the period from 08/20/91 through 09/17/91, a total of 41 dust concentration measurements for a total of 309 minutes were made on 18 different days at a variety of locations on the Vandever and Desiderio mine sites. The total time-weighted dust concentration over the entire study was .011 ug/L, which, if breathed continuously for 60 hours per week and 50 weeks per year at maximum previously-measured uranium and radium concentrations, would result in a committed effective dose equivalent (cede) of 0.32 mrem.

G. L. Gels
09/25/91

Table 1

Date	Time	Location	Zero	Cal.	Measurement Time	Concentration Range, ug/L		
VANDEVER								
08/20	08:50	HP checkpoint	-.000	2.50	5 min	to .006 ug/L		
	09:20	30-200 m N of dozers	--	----	3	to .007		
	09:40	50-150 m N of dozers	-.004	----	3	.000 to .016		
	11:45	HP cp, downwind	-.000	2.50	2	to .004		
	16:37	HP cp, upwind	-.000	----	3	.003 to .012		
08/21	08:50	100-200m dnwnd of dzers	-.000	----	2	.006 to .012		
	09:10	"	.002	----	3	.008 to .016		
	10:50	HP cp	-.000	----	4	.003 to .006		
	15:27	30-200 m dnwnd of dzers	-.000	----	5	.000 to .005		
	15:49	HP cp	-.000	----	2	.000 to .006		
	15:51	HP cp. Car passes-4 ft	---	----	0.5	.002 to .623		
						to .003		
08/22	09:00	HP cp dwnwnd	-.000	2.50	5	.003 to .006		
	14:30	200-500 m S of dozers	-.000	2.50	10	.001 to .013		
08/23	09:00	HP cp	-.000	2.50	6	.003 to .005		
	14:32	HP cp	-.000	2.50	8	.003 to .005		
08/24	08:59	HP cp, Sec 24, Brwn-Van	-.000	2.50	7	.001 to .007		
						MIN	MAX	AVG
	09:17	75 m NW of dozer	-.000 to -.004	----	12	.000	.023	.006
	09:40	SW sector of Sec 24	-.000	2.50	5	.002	.005	.003
08/26	08:58	HP cp	-.000	2.50	10	.008	.208	.012
	14:08	HP cp	-.000	----	4	.004	.013	.009
	15:43	HP cp VERY windy (thunderstorm)	-.001	----	8	.005	.371	.040
08/28	13:20	HP cp	-.000	2.50	5	.002	.008	.005
DESIDERIO								
09/03	10:55	HP cp	-.000	2.50	5	.002	.004	.003
09/04	10:10	HP cp	-.000	2.50	5	.003	.006	.005
	15:10	SW of pit	-.000	----	5	.000	.000	.000
	15:20	North side of NE pit	-.000	----	5	.003	.042	.022
09/07	17:05	HP cp	-.000	2.50	5	.010	.170	.026
09/09	15:30	HP cp, 25 m downwind of loader	-.000	2.50	30	.003	.174	.030
09/10	09:06	HP cp, dozer 75 m upwnd	-.000	2.49	10	.003	.015	.009
	13:50	HP cp dozer near	-.000	----	12	.000	.058	.011
09/11	07:50	HP cp	-.000	2.50	10	.008	.011	.009
	15:25	HP cp	-.001	----	10	.002	.141	.004
09/12	08:25	HP cp	-.000	2.50	10	.004	.040	.008
	14:05	HP cp	-.000	----	10	.000	.071	.005
09/13	11:30	HP cp	-.000	2.50	15	.000	.015	.004
	15:45	HP cp	-.000	----	10	.000	.006	.002
09/14	10:55	HP cp	-.000	2.50	7	.003	.006	.005
	16:55	HP cp	-.000	----	5	.002	.004	.003
09/16	08:30	HP cp, dozer 100m upwnd	-.000	2.49	15	.003	.045	.010
	13:40	HP cp, dozer 50-100 m upwind	-.000	----	10	.003	.257	.035
09/17	11:15	HP cp	-.000	2.50	10	.004	.014	.008
	14:35	HP cp	-.000	----	8	.002	.007	.005

Table 2
Bluewater Uranium
Average Dust Concentration Calculation

DATE	MEASUREMENT TIME (MIN)	AVG DUST CONC (ug/L)
08/20/91	5	0.004
	3	0.005
	3	0.008
	2	0.003
	3	0.008
08/21/91	2	0.009
	3	0.012
	4	0.005
	5	0.003
	2	0.003
08/22/91	5	0.005
	10	0.007
08/23/91	6	0.004
	8	0.004
08/24/91	7	0.005
	12	0.006
	5	0.003
08/26/91	10	0.012
	4	0.009
	8	0.04
08/28/91	5	0.005
09/03/91	5	0.003
09/04/91	5	0.005
	5	0
	5	0.022
09/07/91	5	0.026
09/09/91	30	0.03
09/10/91	10	0.009
	12	0.011
09/11/91	10	0.009
	10	0.004
09/12/91	10	0.008
	10	0.005
09/13/91	15	0.004
	10	0.002
09/14/91	7	0.005
	5	0.003
09/16/91	15	0.01
	10	0.035
09/17/91	10	0.008
	8	0.005
TOTAL:	309	

AVERAGE TIME-WEIGHTED
DUST CONCENTRATION: 0.01091

Bluewater Uranium Mines Site

	Maximum measured concentrations			rem(lung)/uCi of intake	
				Class W	Class Y
^{238}U:	390 pCi/g	=	3.9×10^{-4} uCi/g	52	1000
^{235}U:	29	=	2.9×10^{-5}	56	1000
^{234}U:	330	=	3.3×10^{-4}	59	1100
^{226}Ra:	450	=	4.5×10^{-4}	59	--

If a person inhaled one gram (1 g) of dust at maximum measured concentrations, he would inhale:

3.9×10^{-4} uCi of	^{238}U leading to a (50 yr) lung dose of	.0203 rem
2.9×10^{-5}	^{235}U	.0016
3.3×10^{-4}	^{234}U	.0195
4.5×10^{-4}	^{226}Ra	.0266

using the Class W lung retention factors.

Summing the doses from the four radionuclides gives a total lung dose per gram of dust inhaled of

.068 rem(lung)/g(dust)

Or, using a lung weighting factor of 0.12,

.0082 rem(cede)/g(dust)

Or,

<u>8.2 mrem(cede)/g(dust)</u> [Class W]

Doing the same exercise for Class Y factors for the uranium isotopes, a person would inhale (per gram of dust):

3.9×10^{-4} uCi of	^{238}U leading to a (50 yr) lung dose of	.390 rem
2.9×10^{-5}	^{235}U	.029
3.3×10^{-4}	^{234}U	.363
4.5×10^{-4}	^{226}Ra	.0266

using the Class Y lung retention factors.

Summing the doses from the four radionuclides gives a total lung dose per gram of dust inhaled of

.81 rem(lung)/g(dust)

Or, using a lung weighting factor of 0.12,

.097 rem(cede)/g(dust)

Or,

<u>97 mrem(cede)/g(dust)</u> [Class Y]

To keep the dose for the job below 100 mrem per 60 hr. week, or 1.67 mrem/hr, one could not breathe dust at a concentration greater than w_c (for Class W) or y_c (for Class Y), where

$$w_r = [1.67 \text{ mrem/hr}]/[8.2 \text{ mrem/g}] = .204 \text{ g/hr}$$

and

$$y_r = [1.67 \text{ mrem/hr}]/[97 \text{ mrem/g}] = .0172 \text{ g/hr}$$

So, at 20 L/min x 60 min/hr = 1200 L/hr, the dust concentration must be less than:

$$w_c = [.204 \text{ g/hr}]/[1200 \text{ L/hr}] = 1.7 \times 10^{-4} \text{ g/L} = 170 \text{ ug/L}$$

and

$$y_c = [.0172 \text{ g/hr}]/[1200 \text{ L/hr}] = 1.43 \times 10^{-5} \text{ g/L} = 14.3 \text{ ug/L}$$

These are the dust concentrations at which respiratory protection is required. This calculation is based upon the highest measured concentrations of each nuclide and the presence of the calculated dust concentrations for 60 working hours per week.

G. L. Gels
8/11/91

APPENDIX C

POST RECLAMATION GAMMA SURVEY DATA
SEPTEMBER, 1991

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-9	-1	30
-10	-1	20
-11	-1	18
-12	-1	18
-13	-1	15
-14	-1	20
-15	-1	18
-16	-1	27
-17	-1	18
-18	-1	18
-8	-2	24
-9	-2	20
-10	-2	18
-11	-2	16
-12	-2	16
-13	-2	20
-14	-2	32
-15	-2	56
-16	-2	20
-17	-2	18
-18	-2	14
-8	-3	24
-9	-3	28
-10	-3	27
-11	-3	20
-12	-3	18
-13	-3	18
-14	-3	30
-15	-3	30
-16	-3	21
-17	-3	14
-18	-3	12
0	-4	26
-1	-4	24
-2	-4	22
-3	-4	28
-4	-4	25
-5	-4	28
-6	-4	22
-7	-4	18
-8	-4	22
-9	-4	24
-10	-4	41
-11	-4	40
-12	-4	18
-13	-4	18
-14	-4	24
-15	-4	22
-16	-4	16
-17	-4	12

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-18	-4	12
0	-5	22
-1	-5	20
-2	-5	20
-3	-5	36
-4	-5	20
-5	-5	22
-6	-5	24
-7	-5	36
-8	-5	46
-9	-5	56
-10	-5	50
-11	-5	22
-12	-5	24
-13	-5	20
-14	-5	18
-15	-5	20
-16	-5	14
-17	-5	12
-18	-5	14
0	-6	24
-1	-6	20
-2	-6	20
-3	-6	32
-4	-6	24
-5	-6	23
-6	-6	26
-7	-6	30
-8	-6	24
-9	-6	34
-10	-6	42
-11	-6	20
-12	-6	34
-13	-6	22
-14	-6	20
-15	-6	20
-16	-6	14
-17	-6	12
-18	-6	14
0	-7	23
-1	-7	20
-2	-7	20
-3	-7	20
-4	-7	20
-5	-7	26
-6	-7	40
-7	-7	30
-8	-7	36
-9	-7	24
-10	-7	38

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-11	-7	42
-12	-7	24
-13	-7	39
-14	-7	28
-15	-7	22
-16	-7	18
-17	-7	24
-18	-7	14
0	-8	28
-1	-8	26
-2	-8	22
-3	-8	18
-4	-8	18
-5	-8	20
-6	-8	30
-7	-8	30
-8	-8	34
-9	-8	24
-10	-8	24
-11	-8	34
-12	-8	44
-13	-8	34
-14	-8	24
-15	-8	20
-16	-8	20
-17	-8	22
-18	-8	14
0	-9	22
-1	-9	24
-2	-9	20
-3	-9	20
-4	-9	18
-5	-9	20
-6	-9	22
-7	-9	24
-8	-9	32
-9	-9	40
-10	-9	22
-11	-9	50
-12	-9	26
-13	-9	32
-14	-9	16
-15	-9	18
-16	-9	34
-17	-9	36
-18	-9	40
0	-10	28
-1	-10	18
-2	-10	20
-3	-10	20

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-4	-10	24
-5	-10	38
-6	-10	50
-7	-10	26
-8	-10	28
-9	-10	30
-10	-10	38
-11	-10	32
-12	-10	36
-13	-10	20
-14	-10	18
-15	-10	20
-16	-10	42
-17	-10	32
-18	-10	34
0	-11	26
-1	-11	24
-2	-11	20
-3	-11	26
-4	-11	32
-5	-11	46
-6	-11	40
-7	-11	40
-8	-11	32
-9	-11	56
-10	-11	36
-11	-11	22
-12	-11	20
-13	-11	18
-14	-11	24
-15	-11	20
0	-12	26
-1	-12	22
-2	-12	22
-3	-12	30
-4	-12	32
-5	-12	46
-6	-12	46
-7	-12	36
-8	-12	50
-9	-12	44
-10	-12	32
-11	-12	20
-12	-12	18
-13	-12	14
0	-13	26
-1	-13	26
-2	-13	24
-3	-13	26
-4	-13	24

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-5	-13	44
-6	-13	55
-7	-13	50
-8	-13	36
-9	-13	34
-10	-13	36
-11	-13	20
-12	-13	22
-13	-13	14
0	-14	42
-1	-14	28
-2	-14	44
-3	-14	28
-4	-14	44
-5	-14	30
-6	-14	44
-7	-14	56
-8	-14	32
-9	-14	22
-10	-14	16
-11	-14	22
-12	-14	20
-13	-14	16
0	-15	55
-1	-15	26
-2	-15	36
-3	-15	23
-4	-15	50
-5	-15	56
-6	-15	50
-7	-15	50
-8	-15	42
-9	-15	30
-10	-15	28
-11	-15	26
-12	-15	18
-13	-15	14
0	-16	32
-1	-16	26
-2	-16	44
-3	-16	24
-4	-16	56
-5	-16	50
-6	-16	46
-7	-16	40
-8	-16	24
-9	-16	26
-10	-16	20
-11	-16	14
-12	-16	14

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
-13	-16	12
0	-17	32
-1	-17	30
-2	-17	40
-3	-17	24
-4	-17	36
-5	-17	55
-6	-17	50
-7	-17	40
-8	-17	34
-9	-17	24
-10	-17	26
-11	-17	16
-12	-17	16
-13	-17	10
0	-18	22
-1	-18	32
-2	-18	38
-3	-18	26
-4	-18	48
-5	-18	56
-6	-18	56
-7	-18	50
-8	-18	24
-9	-18	18
-10	-18	20
-11	-18	18
-12	-18	12
0	-19	26
-1	-19	50
-2	-19	30
-3	-19	42
-4	-19	46
-5	-19	44
-6	-19	40
-7	-19	50
-8	-19	22
-9	-19	18
-10	-19	14
-11	-19	12
0	-20	80
-1	-20	30
-2	-20	34
-3	-20	22
-4	-20	32
-5	-20	56
-6	-20	30
-7	-20	30
-8	-20	18
-9	-20	16

Nanabah-Vandever Site, Section 24
Post-Remediation Survey, August, 1991

West	South	Waist uR/hr
0	-21	26
-1	-21	26
-2	-21	36
-3	-21	20
-4	-21	36
-5	-21	50
-6	-21	30
-7	-21	24
-8	-21	24
-9	-21	14
0	-22	24
-1	-22	22
-2	-22	20
-3	-22	22
-4	-22	26
-5	-22	24
-6	-22	50
-7	-22	34
-8	-22	20
-9	-22	14
0	-23	28
-1	-23	28
-2	-23	24
-3	-23	22
-4	-23	34
-5	-23	50
-6	-23	36
-7	-23	16
-8	-23	30
-9	-23	10
	Avg Gamma	28.19 uR/hr

Brown-Vandever Site, Section 18
Post-Remediation Survey, August, 1991

West	North	uR/hr Waist	uR/hr Ground (pre-response)
-4	0	18	26
-3	0	12	120
-2	0	18	32
-1	0	10	31
0	0	20	60
-4	1	12	27
-3	1	12	32
-2	1	15	32
-1	1	16	42
0	1	20	120
1	1	15	40
2	1	18	26
-4	2	12	25
-3	2	12	28
-2	2	12	35
-1	2	16	55
0	2	14	145
1	2	12	60
2	2	14	44
3	2	12	27
4	2	12	
5	2	12	24
-4	3	10	25
-3	3	20	60
-2	3	14	115
-1	3	10	75
0	3	12	140
1	3	12	60
2	3	14	110
3	3	12	85
4	3	12	28
5	3	14	
6	3	12	
-5	-4	12	25
-4	4	12	75
-3	4	16	75
-2	4	12	100
-1	4	10	125
0	4	10	50
1	4	14	105
2	4	12	120
3	4	16	350
4	4	12	370
5	4	12	32
6	4	14	
-4	5	18	29
-3	5	12	38
-2	5	10	55
-1	5	12	75
0	5	12	42

Brown-Vandever Site, Section 18
Post-Remediation Survey, August, 1991

West	North	uR/hr Waist	uR/hr Ground (Pre-response)
1	5	12	55
2	5	14	70
3	5	14	600
4	5	12	80
5	5	16	
-4	6	12	21
-3	6	12	25
-2	6	10	65
-1	6	12	105
0	6	10	70
1	6	12	120
2	6	12	115
3	6	12	240
4	6	12	300
5	6	16	500
-5	7	14	
-4	7	12	23
-3	7	16	26
-2	7	34	85
-1	7	14	600
0	7	12	800
1	7	12	450
2	7	12	95
3	7	12	290
4	7	12	330
5	7	12	250
-6	8	14	
-5	8	12	
-4	8	12	21
-3	8	12	26
-2	8	12	75
-1	8	16	380
0	8	10	125
1	8	12	65
2	8	12	115
3	8	12	80
4	8	12	100
5	8	12	50
-4	9	14	21
-3	9	12	25
-2	9	12	26
-1	9	12	39
0	9	12	38
1	9	12	90
2	9	12	300
3	9	12	220
4	9	12	200
5	9	12	36
-4	10	10	19
-3	10	12	24

Brown-Vandever Site, Section 18
Post-Remediation Survey, August, 1991

West	North	Waist (uR/hr)	Ground (uR/hr) (Pre-response)
-2	10	14	23
-1	10	10	28
0	10	12	33
1	10	12	50
2	10	12	350
3	10	12	130
4	10	12	170
5	10	18	32
-4	11	12	19
-3	11	10	20
-2	11	12	20
-1	11	12	25
0	11	14	36
1	11	12	160
2	11	10	30
3	11	14	250
4	11	12	50
-4	12	12	18
-3	12	12	19
-2	12	12	20
-1	12	12	23
0	12	10	27
1	12	12	25
2	12	12	50
3	12	12	24
4	12	12	24
-4	13	12	17
-3	13	12	19
-2	13	12	18
-1	13	10	19
0	13	10	22
1	13	14	22
2	13	12	20
3	13	12	16
4	13	12	20
6	6	12	32
6	7	12	30
-5	5	12	21

Avg Gamma 12.84 uR/hr

Desiderio Site
Post-Remediation Survey, September, 1991

Pre-Remediation Grid		Waist	Post-Remediation Grid	
South	West	uR/hr	North	East
24.7	32.1	11	N0	E0
24.2	29.9	39	N0	E1
23.6	27.6	12	N0	E2
23.1	25.4	11	N0	E3
22.5	23.1	11	N0	E4
22.0	20.9	14	N0	E5
21.4	18.6	14	N0	E6
20.9	16.4	12	N0	E7
20.3	14.1	13	N0	E8
19.8	11.9	13	N0	E9
19.2	9.6	13	N0	E10
18.7	7.4	15	N0	E11
22.4	32.6	17	N1	E0
21.9	30.4	13	N1	E1
21.3	28.1	14	N1	E2
20.8	25.9	12	N1	E3
20.3	23.7	12	N1	E4
19.7	21.4	15	N1	E5
19.2	19.2	12	N1	E6
18.6	16.9	12	N1	E7
18.1	14.7	14	N1	E8
17.5	12.4	19	N1	E9
17.0	10.2	40	N1	E10
16.4	7.9	22	N1	E11
20.2	33.2	12	N2	E0
19.6	30.9	11	N2	E1
19.1	28.7	13	N2	E2
18.5	26.4	17	N2	E3
18.0	24.2	13	N2	E4
17.4	21.9	12	N2	E5
16.9	19.7	11	N2	E6
16.3	17.4	12	N2	E7
15.8	15.2	14	N2	E8
15.3	13.0	16	N2	E9
14.7	10.7	18	N2	E10
14.2	8.5	28	N2	E11
17.9	33.7	15	N3	E0
17.4	31.5	22	N3	E1
16.8	29.2	12	N3	E2
16.3	27.0	11	N3	E3
15.7	24.7	15	N3	E4
15.2	22.5	11	N3	E5
14.6	20.2	12	N3	E6
14.1	18.0	10	N3	E7
13.5	15.7	50	N3	E8
13.0	13.5	18	N3	E9
12.4	11.2	14	N3	E10
11.9	9.0	25	N3	E11
15.6	34.2	12	N4	E0

Desiderio Site
Post-Remediation Survey, September, 1991

Pre-Remediation Grid		Waist	Post-Remediation Grid	
South	West	uR/hr	North	East
15.1	32.0	13	N4	E1
14.5	29.7	13	N4	E2
14.0	27.5	12	N4	E3
13.5	25.3	17	N4	E4
12.9	23.0	12	N4	E5
12.4	20.8	12	N4	E6
11.8	18.5	11	N4	E7
11.3	16.3	20	N4	E8
10.7	14.0	30	N4	E9
10.2	11.8	30	N4	E10
9.6	9.5	14	N4	E11
13.4	34.8	12	N5	E0
12.8	32.5	15	N5	E1
12.3	30.3	13	N5	E2
11.7	28.0	14	N5	E3
11.2	25.8	11	N5	E4
10.6	23.5	12	N5	E5
10.1	21.3	11	N5	E6
9.5	19.0	14	N5	E7
9.0	16.8	18	N5	E8
8.5	14.6	14	N5	E9
7.9	12.3	18	N5	E10
7.4	10.1	13	N5	E11
11.1	35.3	15	N6	E0
10.6	33.1	25	N6	E1
10.0	30.8	32	N6	E2
9.5	28.6	15	N6	E3
8.9	26.3	11	N6	E4
8.4	24.1	12	N6	E5
7.8	21.8	10	N6	E6

Avg Gamma 15.86 uR/hr

<u>APPENDIX D</u>

ATSDR POST RECLAMATION LETTER

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service
Agency for Toxic Substances
and Disease Registry

Memorandum

Date September 24, 1991

From William Q. Nelson, Senior Regional Representative, Region IX

Subject Review of Response Actions at the Bluewater Uranium Site

To Robert Bornstein, EPA OSC/ERS, H-8-3, Rm 8155

The Agency for Toxic Substances and Disease Registry (ATSDR) has reviewed the draft and final document dated September 23, 1991, describing the past removal action summary of exposure for the above site.

In consultation with Dr. Paul Charp of ATSDR, we find that the described removal actions are satisfactory for those areas indicated and are protective of public health.

INDOOR RADON AT VANDEVER AND DESIDERIO MINE SITES

There is some concern about indoor radon concentrations at the Vandever and Desiderio uranium mine sites (the Bluewater Mine Sites) near Prewitt, New Mexico. Strip mining operations occurred at both of these locations in the past, indicating that relatively rich uranium deposits lie fairly close to the surface and in close proximity to the home sites.

Two questions need to be answered at these locations: (1) How do indoor concentrations measured at these two sites compare with concentrations measured elsewhere? And, (2) Is it either likely or possible that past mining operations have adversely affected the radon concentrations indoors?

To answer the first question, it has been reported that a concentration of 4.6 pCi/L has been measured at one of the homes at the Desiderio Site, as well as concentrations between 1.5 and 3.3 pCi/L at other homes on site. These measurements were taken with alpha track detectors left in place for two to three months. The results reported at the mine sites are typical for this area (IHS survey, January, 1990,) and in most areas of the country. In the immediate Bluewater area, thirteen homes were measured in the IHS survey, ranging from <1.0 to 7.5 pCi/L, with the average being 2.5 pCi/L. As another point of comparison, a survey in North Dakota showed average radon concentrations of about 6 pCi/L. The conclusion is that there seems to be nothing unusual about the results reported at the two mine sites.

Is it likely, or even possible, that past mining operations have affected indoor concentrations at these sites? The source of indoor radon is the soil in direct proximity to the home. The distance that radon can travel before it decays is directly related to the soil porosity and inversely related to the moisture content. The two mine sites contain a soil horizon composed of fine to coarse grain sand and weathered limestone. The soil porosity is high and the moisture content is low. Therefore, the soil possesses very good soil gas diffusion characteristics. However, since the mean diffusion path length for a radon atom is only a few meters at most before it decays, and since no mining operations have taken place within 50 meters of any on the homes, it is unlikely that the mining operations have in any way affected the soil gas radon concentrations near the homes.

Since these two sites are not "normal" sites as far as the potential for outdoor concentrations of radon, the additional question might be asked, "Could these homes be affected by airborne radon from nearby exposed uranium seams or open mine shafts?". It is difficult to answer "No" to such a speculative question, since outdoor concentration measurements have never been made to my knowledge. However, it is very unlikely that increases in outdoor concentrations near the homes have occurred as a result of mining operations. The distance of the homes from any potential airborne sources plus the vast volume of mixing air between source and receptor support this conclusion. Indirectly, it must be noted that while radon soil gas measurements have been used as a prospecting tool, radon air concentration measurements have never been used to prospect for uranium. This indicates that increased air concentrations are not associated with rich uranium soil deposits, and thus one would not expect to see any increase in airborne radon concentrations near the homes on these sites.

In conclusion, it does not appear that any increased indoor radon concentrations should be expected or have been measured at the homes on the Vandever and Desiderio sites. Additional long-term measurements following EPA protocols may help clarify this conclusion. It is recommended that any new home construction, particularly on land included as part of this removal action, include piping and sub-foundation gravel consistent with EPA recommendations for new home construction, so that if elevated concentrations are encountered (as have been in 8.3% of the homes in the IHS study), mitigation procedures will be cheap and effective.

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 2

P. ANTONIO MARCH'92

PRELIMINARY ASSESSMENT

DATE : May 20, 1990

Prepared by: Patrick Molloy, Health Physicist, Navajo Superfund Office

Site : Navajo - Brown Vandever Uranium Mine

EPA ID # : Not assigned

SITE INFORMATION

Site Location. The Brown Vandever Uranium Mine (Brown Uranium Mine, sic)is located approximately 4 miles east of Prewitt, New Mexico. The site is also located approximately 20 miles north-northwest of Grants, New Mexico (figure# 1). The site may be found by proceeding east from the Prewitt, New Mexico post office on the Interstate 40 frontage road approximately 1 mile and subsequently traveling east on an improved dirtroad for approximately 5 miles (figure #2). The road turns north at the eastern edge of Haystack mountain, a prominent geological feature in the area. The site is located on the southeastern margin of Haystack mountain approximately 1 mile north of El Tintero cinder cone (figure #2). The Geographic coordinates for the site are 35° 21' 02" N latitude and 107°56'25" W longitude (7).

The mine is located on an expired mining claim of approximately ¼ section in area. Approximately 65 persons, including small childern live on-site in a semi-agricultural rural setting (3,4; worksheet #2, 7). Two inclined adits, an almost vertical timbered shaft, two vertical ventilation shafts and a strip mine covering approximately 100 acres are notable features of the abandoned claim (3; Frames).

OWNER AND OPERATOR. The Brown Vandever Mine is currently owned, and was owned throughout its history by the Navajo Nation (17). The land is held in trust for the Navajo Nation by the Federal Government through the authority of the Bureau of Indian Affairs (BIA).

The primary lease holders for the claim were variously; Williams and Thompson (full names not found) and Mr. Brown Vandever (2;pg 1-276, 3-5). The site was presumably subleased to the various operators (2; page 3-5). Several other mines are to be found in the area the most notable being the Haystack 2 mine (11). The lease is currently owned by the Navajo Nation (17).

PURPOSE OF INVESTIGATION The Brown Vandever Uranium Mine was reported to be a potentially contaminated waste site by the Navajo Superfund office field reconnaissance team in 1990 (1).

SITE HISTORY The Brown Vandever Uranium Mine is located in the Ambrosia Lake sub-district of the Grants Mining District (7,10). No Historical record for naturally occuring radiation levels for the area has survived until the present. Two inclined adits were driven north-northwestward into the dip of the Todilto formation (3;frame #12, figure #4). These inclines were reported to be approximately 300 ft. deep (14; page #6, direct quote): additionally, two 400 yd. drifts were driven into the ore bodies associated with the incline in Frame #12 (14; page #2).

A timbered shaft inclined at approximately 10° from the vertical, was driven into the dip of the Todilto formation approximately 1000 ft. west of the inclined adits (3; frame #33). This shaft was reported to be approximately 300 ft. deep (14; page #6): drifts were also excavated northwest and northeast from the shaft.

Two, two-foot diameter vertical shafts were excavated between the inclined adits and the timbered shaft in order to provide ventilation for the mining operation (3; frame #33); the ventilation shafts were reported to be approximately 300 ft. deep (Mr. Brown Vandever, personal communication, April 11, 1990).

The area south of the inclined adits has been extensively strip-mined: The area of surface disturbances has been estimated to be approximately 100 acres in extent (4; page # 8, Figure #2). Tailings associated with the N. and B. Vandever Mines were used to "pave" a road leading to the N. Vandever works.

It is presumed that the mining operation was carried out using conventional mining techniques; Due to the extensive and elaborate nature of the surface works and adits (shafts), it is unlikely that manual labor was utilized to any great degree. A powerline extension which was used to provide electricity for an air compressor still exists on site.

The Brown Vandever Uranium Mine was operated intermitently over the period of years from 1952 until 1966 (2). Santa Fe Uranium, Federal Uranium Mesa Mining Co. and Cibola Mining Co. were some of the mining interests involved: Other individuals operated the mine (2).

Mining operations at the site produced 25,796 tons of ore rich in Uranium (U_3O_8,0.) 0.19% grade) and Vanadium (V_2O_5, 0.30% grade). A total of 98,175 lbs of U_3O_8 and 75,342 lbs of V_2O_5 were milled from the raw production tonnage (2, pg# 1-276, 3-5).

It is presumed that the ore was transported to Shiprock, New Mexico or Durango, Colorado for milling. However, no record of where the milling took place was found: It is not known whether the Phillips Petroleum Ambrosia mill was in operation during the time the ore was being produced.

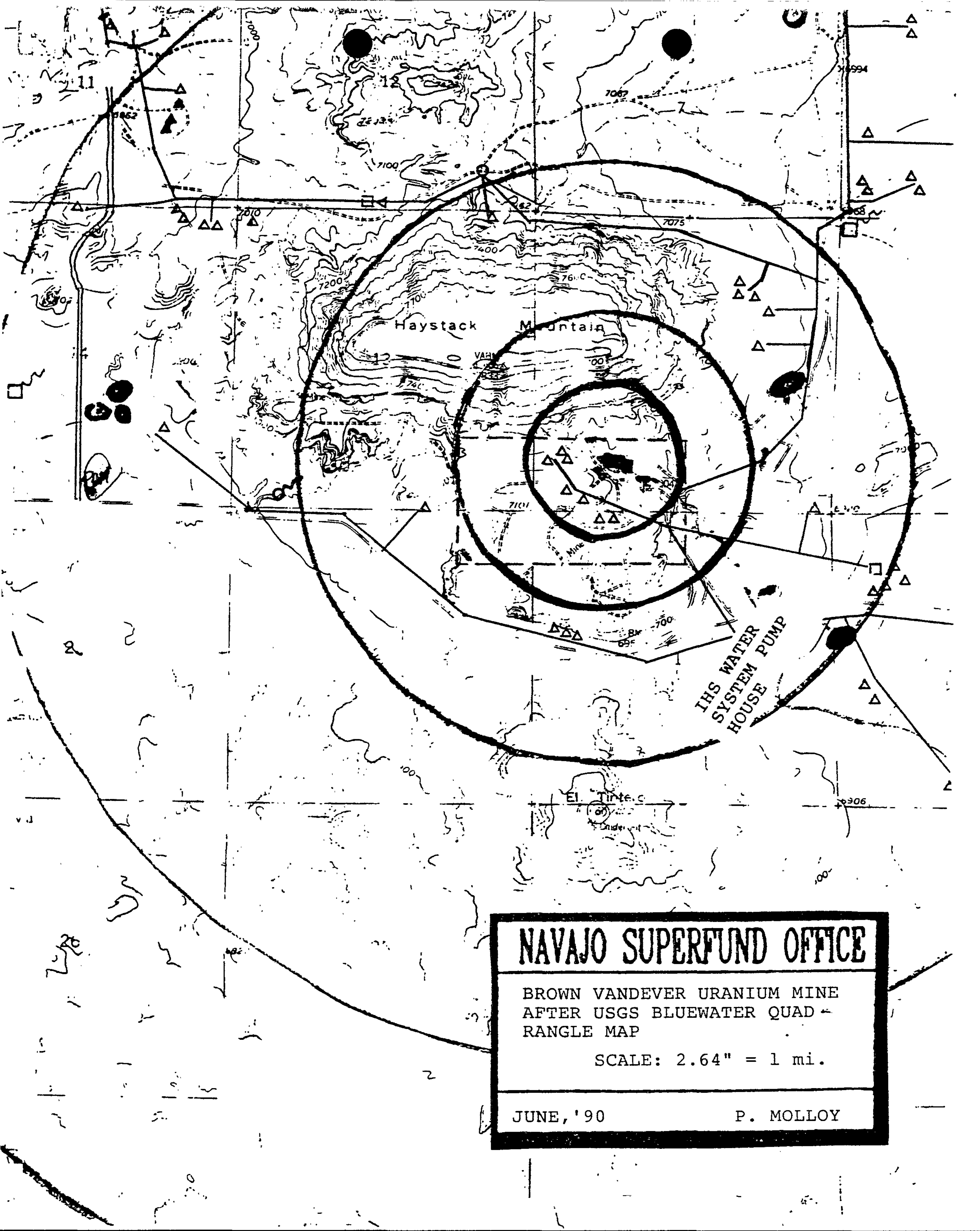
DISSCUSSION OF KNOWN/POTENTIAL PROBLEMS During a windshield survey of the site and environs, in order to ascertain population, population distribution, water usage patterns and area radiometric background

FIGURE # 1 ; REPRINTED BY PERMISSION

NAVAJO SUPERFUND OFFICE

NAVAJO-BROWN VANDEVER URANIUM MINE

JUNE,'90 P. MOLLOY



NAVAJO SUPERFUND OFFICE

BROWN VANDEVER URANIUM MINE
AFTER USGS BLUEWATER QUAD-
RANGLE MAP

SCALE: 2.64" = 1 mi.

JUNE,'90 P. MOLLOY

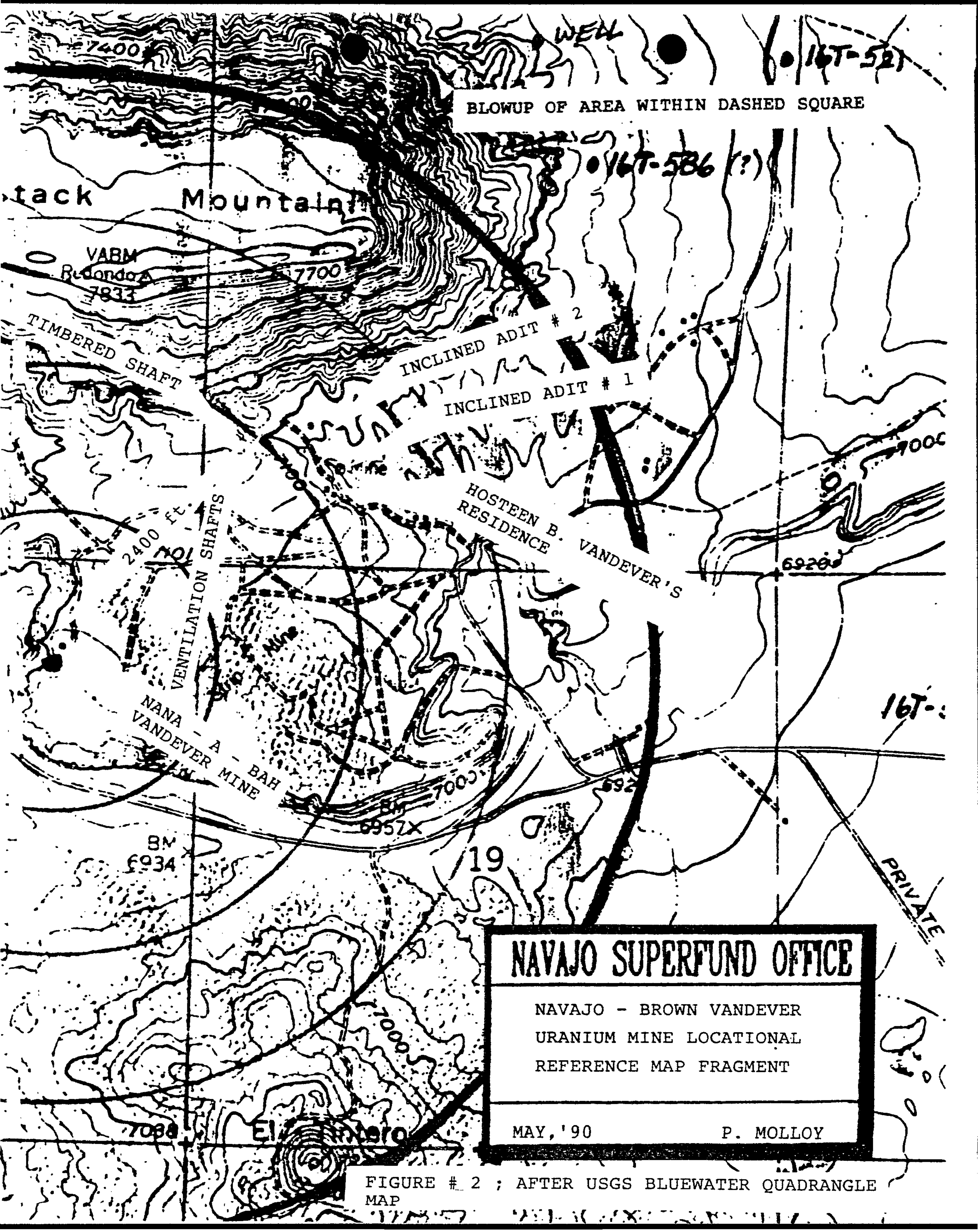
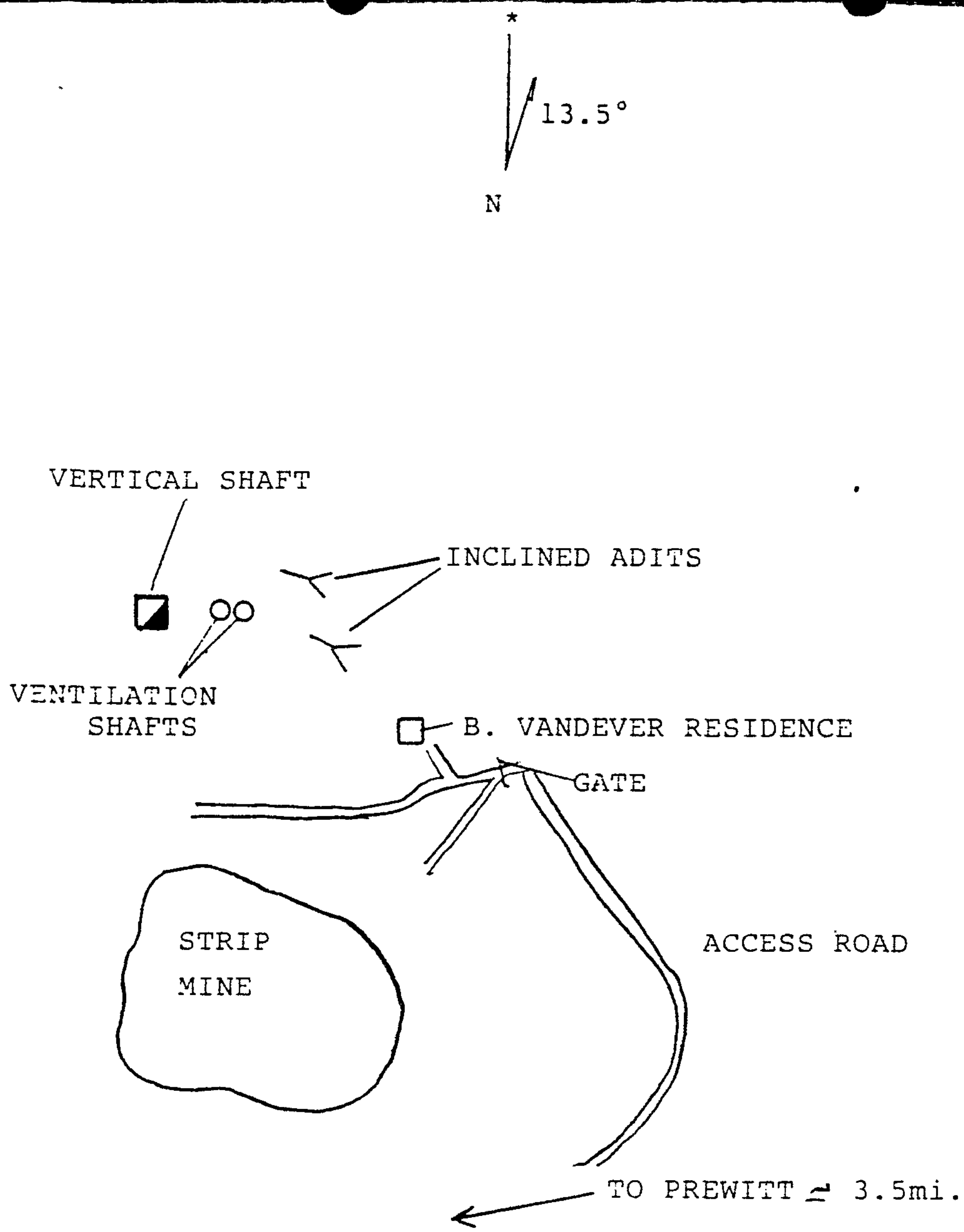


FIGURE # 2 ; AFTER USGS BLUEWATER QUADRANGLE MAP



SCALE - 1" ≃ 1418 ft.

FIGURE # 4 ; SITE SKETCH

NAVAJO SUPERFUND OFFICE

NAVAJO-BROWN VANDEVER URANIUM MINE SITE SKETCH

JUNE, '90 P. MOLLOY

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. NOT ASSIGNED

DATE APRIL 11, 1990 TIME 10:20am WEATHER CLEAR

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 20°/ENE

FILM TYPE POLAROID FRAME NO. 5

DATA TAKEN WITH PHOTOGRAPH: NONE

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey ( )
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES

5TH FR

7. DESCRIPTION HAYSTACK BUTTE, REFERENT, LOOKING E OF ENE

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

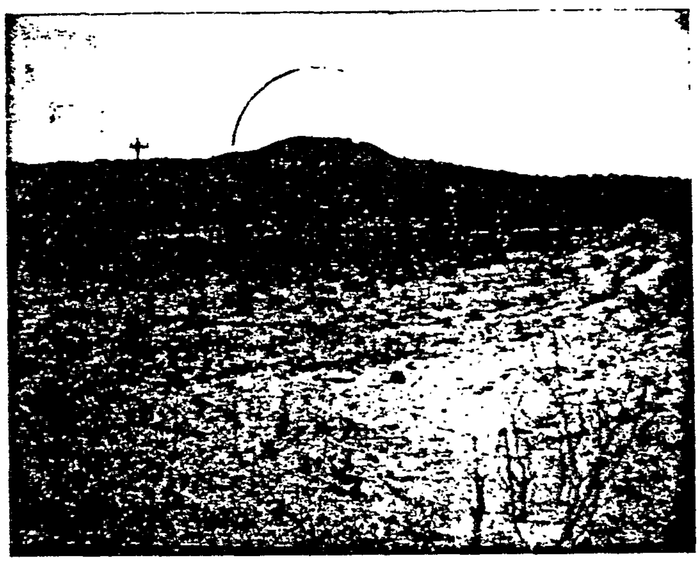
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 270°/S

FILM TYPE POLAROID **FRAME NO.** 20'

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: __________
4. Radiation Survey ( )
   Reading: __________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



60th FR. (EL TINTERO CINDER CONE, REF.)

7. **DESCRIPTION** EL TINTERO CINDER CONE REFERENT, LOOKING S

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 20°/ENE

FILM TYPE POLAROID **FRAME NO.** 7

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (x)
   Reading: LUDLUM#19-24uR.hr^{-1} :: ESP-II - 2.2(10^4)
5. Deep Well Water Sample ( ) BACKGROUND @ B VANDEVER
6. Photograph Below: YES

7th FR.

7. **DESCRIPTION** TRENCH CUT NNE OF B. VANDEVER RESIDENCE, LOOKING NE. NOTE FRAMES 8, 9, 10 TAKEN AT SAME LOCATION

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 10°/N OF NNE

FILM TYPE POLAROID **FRAME NO.** 15

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: 350uR.hr-1(LUDLUM#19) : @ EDGE OF "LOADING BAY"
5. Deep Well Water Sample ( )
6. Photograph Below: YES

15th FR.

7. **DESCRIPTION** TRENCH AT CENTER MIDDLEGROUND IS ORE "LOADING BAY", LOOKING N OF NNE

levels, the following observations were made;

* The population distribution is closely correlated with the Indian Health Service (IHS) water system (tautological).

* Several windmills in the area are no longer in service. At least one windmill shows infrequent use (18; pg #1).

* There are 7 residences on site: not all these residences are connected to the IHS water system.

* The old haulage road (for ore transport) is plainly visible and shows definite erosion: The road that obtains access to the site was at one time the haulage road. There is radiometric evidence that contaminants are migrating off site (18, pg #2).

* A drainage which trends east from the site exhibits radiometric readings consistent with contaminant transport/migration.

* The onsite haulage road was "paved" with mine tailings and provides a receptacle for mechanical transport of contaminants. An Eberline Gamma Ratemeter registered 10^5 cpm at the edge of the road (3; frame #22, 14; page #4) There is radiometric evidence of mechanical (eg, vehicle) transport of contaminants approximately 2 mi. from the site environs via the haulage road (18; page #2)

* The timbered shaft retains a shack at its mouth, however, access to the shaft can easily be gained by removing a wire grate covering the portal (3: Frame #33). Additionally, the shaft "aspirates" under certain meteorological conditions, contributing to the area Radon burden.

* The vertical ventilation shafts are poorly capped and young children in the area could easily gain access to the excavations (3; Frame #33).

* One inclined adit is used for waste disposal (3; Frame #12).

* Small quantities of ore grade material are to be found almost anywhere on site.

* Approximately 1880 tons of tailings materials are presently onsite. The material is uncovered and accessible (3.; Frames #8, #13, #15, #19, Frames #25 through #32).

* The Navajo Superfund Office FIT digilert alerted (enabled) inside the vehicle being used for reconnaissance at one point along the "Hot Road" (3; Frame #22): enable/alert on the device is set at .098 mR.hr-1.

Tailings material, the inclined adits and the timbered shaft are suspected of producing a leachate rich in toxic heavy metals and radioactive contaminants (4,11,23). Radiometric readings taken during

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 180°/W

FILM TYPE POLAROID **FRAME NO.** 16'

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______
4. Radiation Survey (X)
   Reading: SEE BELOW IN DESCRIPTION
5. Deep Well Water Sample ( )
6. Photograph Below: YES , EXTRA FRAME

16TH FR.
MOUTH OF DRAINAGE

7. **DESCRIPTION** MOUTH OF DRAINAGE, TAILINGS PILE ON RIGHT, ESP-II READINGS: @MOUTH - 5(10^4); @MIDWAY PAST TAILING. - 6.5(10^4); @END OF TAILINGS - 3.25(10^4); ALL READINGS IN cpm., LOOKING W

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 0°/E

FILM TYPE POLAROID **FRAME NO.** 22

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (x)
   Reading: 105cpm(ESP-II) @ EDGE OF ROAD
5. Deep Well Water Sample ( )
6. Photograph Below: YES

22 [illegible]

7. **DESCRIPTION** "HOT ROAD" WEST OF B. V. RESIDENCES, SURFACE WORKS WASTE PILES @ RIGHT MIDDLEGROUND, MT. TAYLOR @ UPPER LEFT BACKGROUND AS REFERENT

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE USEPA SITE NO. ~~NOT ASSIGNED~~

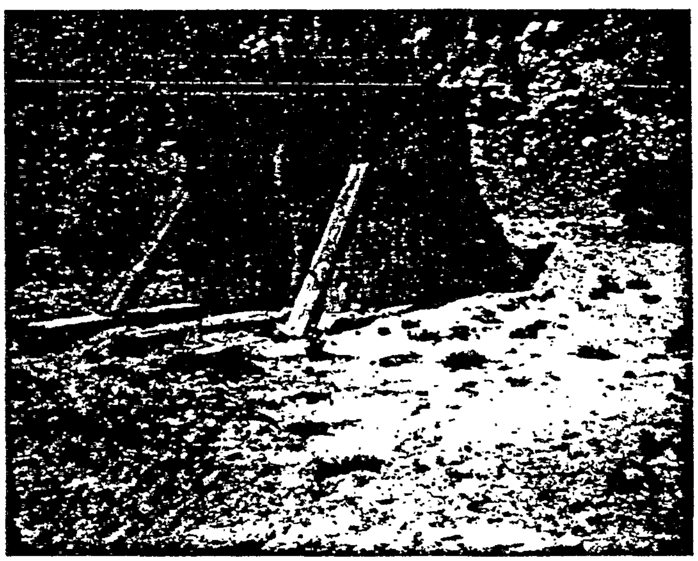
DATE APRIL 11,1990 TIME AFTERNOON WEATHER CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY ANGLE/DIRECTION 135° NW

FILM TYPE POLAROID FRAME NO. 33

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: $10 uR.hr^{-1}$(LUDLUM#19), 10^4cpm(ESP-II) @ WEST FACE OF SHACK
5. Deep Well Water Sample ( )
6. Photograph Below: YES



33 ᵈᵉ FR.

7. DESCRIPTION B. VANDEVER TIMBERED SHAFT, SHAFT AT AN INCLINATION OF 10° FROM VERTICAL, CIRCULAR APERTURE ON S FACING WALL IS WIRED OVER BUT WIRE IS EASILY REMOVED, SHAFT ASPIRATES, "300 FT. DEEP" B. V. TO P. MOLLOY, APRIL 11,1990

PCM

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

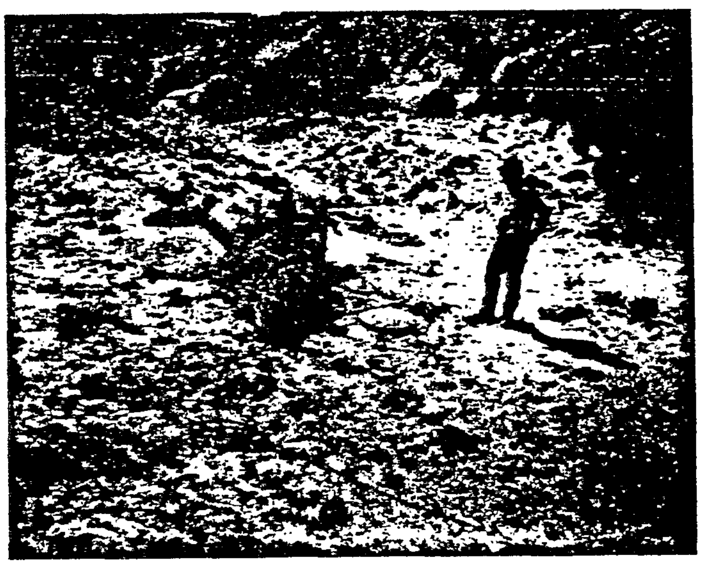
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 250° WNW

FILM TYPE POLAROID **FRAME NO.** 33

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ______________
4. Radiation Survey (X)
   Reading: ______________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



33rd FR.
(VENT. SH. VERTICAL!)

7. **DESCRIPTION** VERTICAL VENTILATION SHAFTS(2), HOSTEEN BROWN VANDEVER AT RIGHT MIDDLEGROUND, SHAFTS "300 FT. DEEP" - B. V. TO P. MOLLOY, APRIL 11,1990, LOOK-WNW

PCM

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** 10:25am **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** [illegible]°/NNW

FILM TYPE POLAROID **FRAME NO.** 12

DATA TAKEN WITH PHOTOGRAPH: YES

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (X)
   Reading: LUDLUM#19 - 21uR.hr^{-1} : @ FACE OF ADIT
5. Deep Well Water Sample ( )
6. Photograph Below: YES

3rd FR.

7. DESCRIPTION INCLINED ADIT N OF B. VANDEVER RESIDENCE, LOOKING NNW

NAVAJO SUPERFUND DEPARTMENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

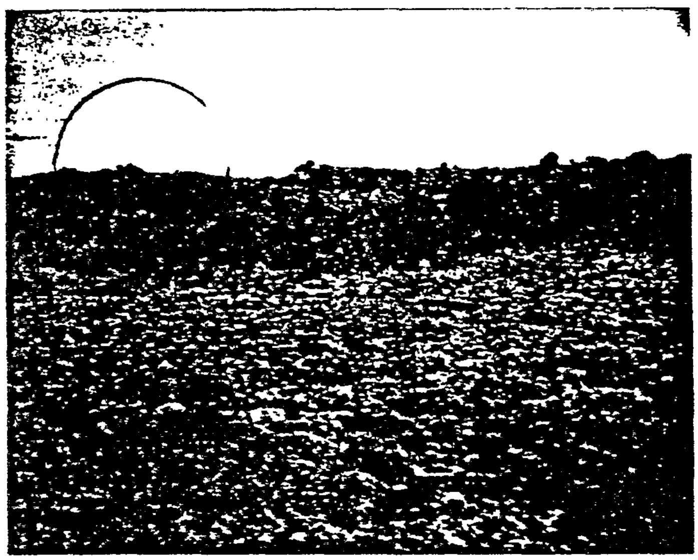
DATE APRIL 11,1990 **TIME** AFTERNOON **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** 350°/E OF ES

FILM TYPE POLAROID **FRAME NO.** 26

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (x)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



26th Fr

7. **DESCRIPTION** SURFACE WORKS WSW OF B. V. RES., LOOKING E OF ESE; NOTE MT. TAYLOR IN FAR LEFT BACKGROUND AS REFERENT

FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

DATE APRIL 11,1990 **TIME** ________ **WEATHER** CLEAR

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** ________

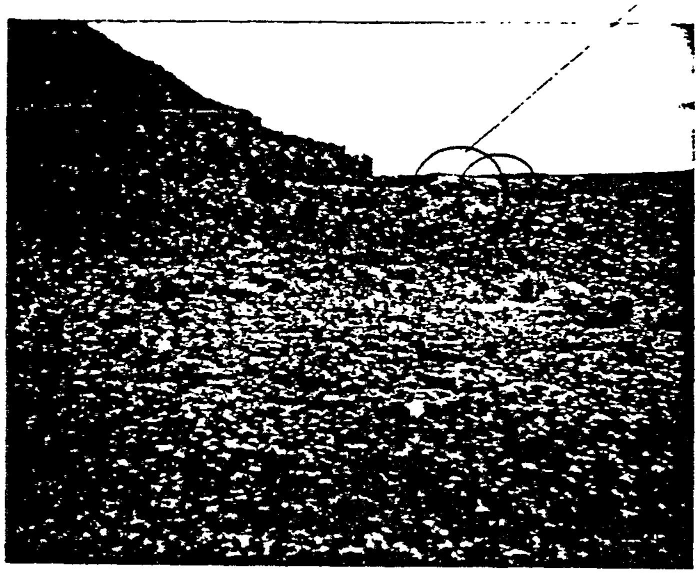
FILM TYPE POLAROID **FRAME NO.** 28

DATA TAKEN WITH PHOTOGRAPH: *** NONE ***

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: ________
5. Deep Well Water Sample ( )
6. Photograph Below: YES, SEE SKETCH

YES, UNCUT

PCM



3 REG.

28 = Fr.

7. DESCRIPTION SEE SKETCH

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FIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

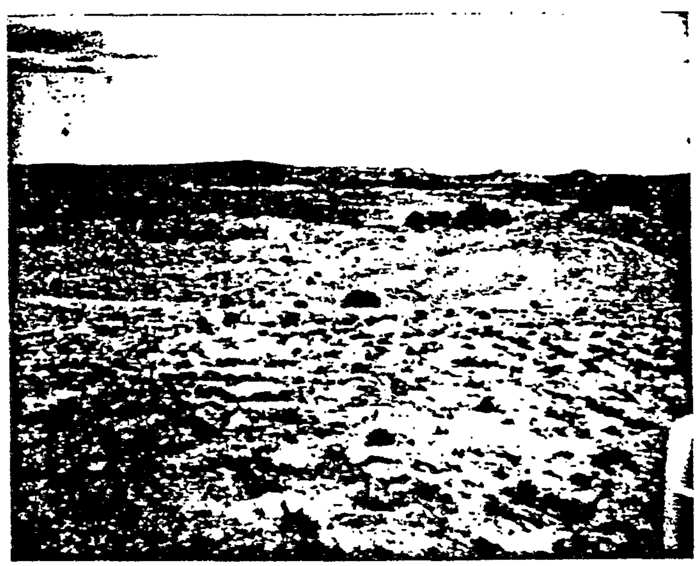
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** SEE SKETCH

FILM TYPE POLAROID **FRAME NO.** 31

DATA TAKEN WITH PHOTOGRAPH:

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ____________
4. Radiation Survey (x)
   Reading: ____________
5. Deep Well Water Sample ( )
6. Photograph Below: YES



51ST FR.

7. DESCRIPTION ____________

NAVAJO SUPERFUND DEPARTMENT

PIT PHOTOGRAPH LOG SHEET

SITE NAME BROWN VANDEVER URANIUM MINE **USEPA SITE NO.** NOT ASSIGNED

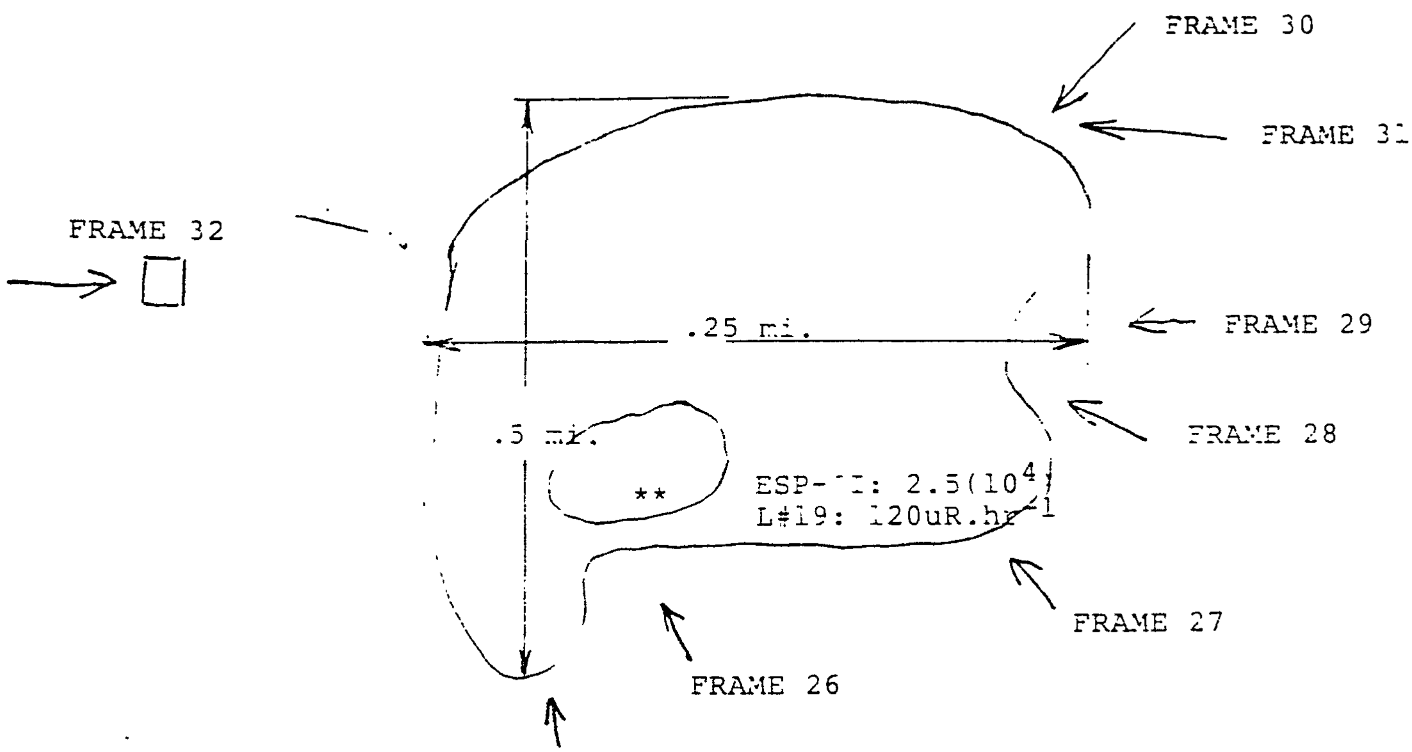
DATE APRIL 11,1990 **TIME** 11:15am **WEATHER** CLEAR TO SLIGHTLY OVERCAST

PHOTOGRAPHER P. MOLLOY **ANGLE/DIRECTION** -

FILM TYPE POLAROID **FRAME NO.** NO FRAME

DATA TAKEN WITH PHOTOGRAPH: SKETCH

1. Soil Sample ( )
2. Surface Water Sample ( )
3. Air Monitoring Device ( )
   Reading: ________
4. Radiation Survey (X)
   Reading: SEE BELOW
5. Deep Well Water Sample ( )
6. Photograph Below: *** NONE ***



* RADIOMETRIC READINGS ASSOCIATED WITH FRAME 27

7. **DESCRIPTION** SKETCH OF AREA WHERE RADIOMETRIC READINGS WERE TAKEN, NO SCALE

a windshield survey indicate that a substantial fraction of ¼ of a section (160 acres) is contaminated with mine tailings. Tailings piles, the incined adits and the timbered shaft are unfenced and readily accesible to site residents (3). There is no documentation of emergencies, accidents or remedial action regarding the Brown Vandever Uranium mine site.

3. WASTE CONTAINMENT/HAZARDOUS SUBSTANCE

An estimated total of 532,000 tons of mining waste is present in the two major tailings piles on site (4). Computations indicate that there are approximately 1880 tons of toxic compounds and elements dessiminated within the 532,000 tons of rubble at the site (3; Frames #8, #13, #15, #19, #25 through #32, 4). These contaminants are exposed and uncontained and are therefore capable of producing leachate subject to migration into atmospheric, ground water and surface water systems (11, 22, 23, 24, 25). The exposed inclined adits, timbered shaft and stopes may also be producing a leachate similar in composition to that produced by the tailings piles.

Specific radioactive species contributing to contamination of the leachate are uranium (U^{235}, U^{238}), and its daughter products Ra^{226}, Th, isotopes of Pb, Bi^{214}, etc). The enclosed portions of the adits and shaft may contain significant concentrations of Radon gas. Toxic heavy metal species suspected of being present in the mining waste in significant concentrations are Vanadium, Arsenic, Barium, Chromium, Magnesium, Manganese, Strontium, Titanium and Zirconium. Table 1 provides a summary of hazardous substances potentially present in the waste piles and in the open excavations.

4. PATHWAY CHARACTERISTICS

A. AIR CHARACTERISTICS

The potential for mobility of hazardous and toxic compounds associated with U_3O_8 and V_2O_5 mining waste is high due to the particulate nature of the waste and the occasional high winds native to the area which may cause migration of windblown contaminants offsite.

B. GROUNDWATER CHARACTERISTICS

Regionally, the site is bounded on the north by the central San Juan Basin and on the south by the Zuni uplift. Structural elements of the Acoma Sag lie southeast of the site (5;pgs 16,18:6). The geological element where the site is located is termed the Chaco slope (5;pg 16).

"Kelley (1951, p. 126) describes the Chaco slope as the southern part of the San Juan Basin that lies between the central Basin (fig. 2.5 -1) and the Zuni uplift and Acoma Sag. The Chaco slope resembles the platforms but differs from them because of "Its more pronounced and continous regional inclination toward the center of the basin and by the absence of a 'Monocline' separating it from the central basin " (Kelley, 1951, p.126).

Jurassic rocks from the Morrison formation and Chinle formation (which

TABLE 1. Quantity of Undisseminated Toxic Compounds and Elements Within Tailings Piles at Brown Vandever Uranium Mine

	Waste	Quantity of Undisseminated Hazardous Waste*	Disposal Location	Origination	
1.	U_3O_8	6.35 (10) kg	On-Site	Low Grade Uranium/ Vanadium	
2.	V_2O_5	1.04 (10 kg	On-Site	"	"
3.	Radium	Unknown	"	"	"
4.	Thorium	"	"	"	"
5.	Arsenic	"	"	"	"
6.	Selenium	"	"	"	"
7.	Radon	"	"	"	"
	TOTAL	**1880 tons**			

* CUSTOMARY UNITS FOR REPORITNG ABUNDANCES OF RADICISOTOPES ARE MASS UNITS.

locally includes the Moenkopi formation) dip westwardly into the adjacent Chaco slope (3; frame# 20 and enlargement: 6:8). A Cretaceous sequence is present adjacent to the site on Haystack mountain and is represented by the Dakota sandstone exposure (3: frame #20 and enlargement). Triassic units represented by the Moenkopi and Chinle formations dip eastwardly into the adjacent Chaco slope (3;frame #20 and enlargement Figure #3).

Quaternary Alluvium (Pleistocene) has accumulated in variable thicknesses in streambeds in the area (32).

The Aquifer of concern in the Vicinity of the site is the Sonsela Sandstone member of the Chinle formation which sources the Navajo Nation Water Resources Division (NNWRD) well #16T-551 (19). Depth to water in ths well is documented and is reported to be 417 feet (circa 1976). Depth to the Sonsela sandstone member of the Chinle formation is 1083 feet. The only other Aquifer known to source wells in the area is the Entrada Sandstone (19). the net precipitation for the locale is estimated to be minus 44 inches (5, 12).

Contaminants of concern present in the tailings piles are the radiospecies U^{238}, U^{235} and their progeny Th^{232}, Bi^{214}, Po^{214}, isotopes of Pb and Radon gas. Toxic heavy metal species suspected of being present in the mining waste in significant concentrations are Ar, Ba, Mg, Mn, Sr, Ti and Zr. (11, table 1). Many of these species have been demonstrated by various authors to be mobile in waters associated with Uranium mines (23,24,25,26,27,28 and 29). The Hydraulic conductivity of the formations between the Alluvium and the Sonsela sandstone member is estimated to be of the order of 10^{-3} because of fractures and faults. This is consistent with the close proximity of the El Tintero Cinder Cone and the epochal geological development of the area. In addition, at least three excavations are driven to within 100 feet of the static water level in NNWRD well #16T-551. It follows that the possibility exists for these Radioactive and toxic heavy metal species to have migrated into the alluvial and Sonsela sandstone Aquifers which source an Artesian spring and NNWRD well #16T-551, respectively (3; frame #35: 19). Water depth in the alluvial Aquifer is not known but is expected to be shallow (5; pg. #40, fig.#4.3-1)

C. SURFACE WATER CHARACTERISTICS

A portion of the Brown Vandever mine site is located on a southeastwardly dipping Alluvial plate (3;frame #8) whose upgradient drainage area is estimated to be approximately 59.1 acres (4; worksheet #1). The stripmine portion of the site is located on a northwardly dipping Alluvial plate whose upgradient drainage area is estimated to be 14.23 acres (4; worksheet #1). Surface runoff from the 59.1 acre portion proceeds overland and along minor drainages eastwardly (3;frame,#16') until encountering a well-defined drainage which trends southeastwardly,(3;frame #17,#18). Surface runoff from the 14.23 acre portion proceeds overland and along minor drainages eastnortheastwardly (3;frame#31) until encountering the well-defined drainage which trends southeastwardly (7). The drainage proceeds southeastwardly for approximately 4 mi. before becoming evanescent (7, 31). Data from a gauging station on the Rio San Jose at Grants, New Mexico indicates an

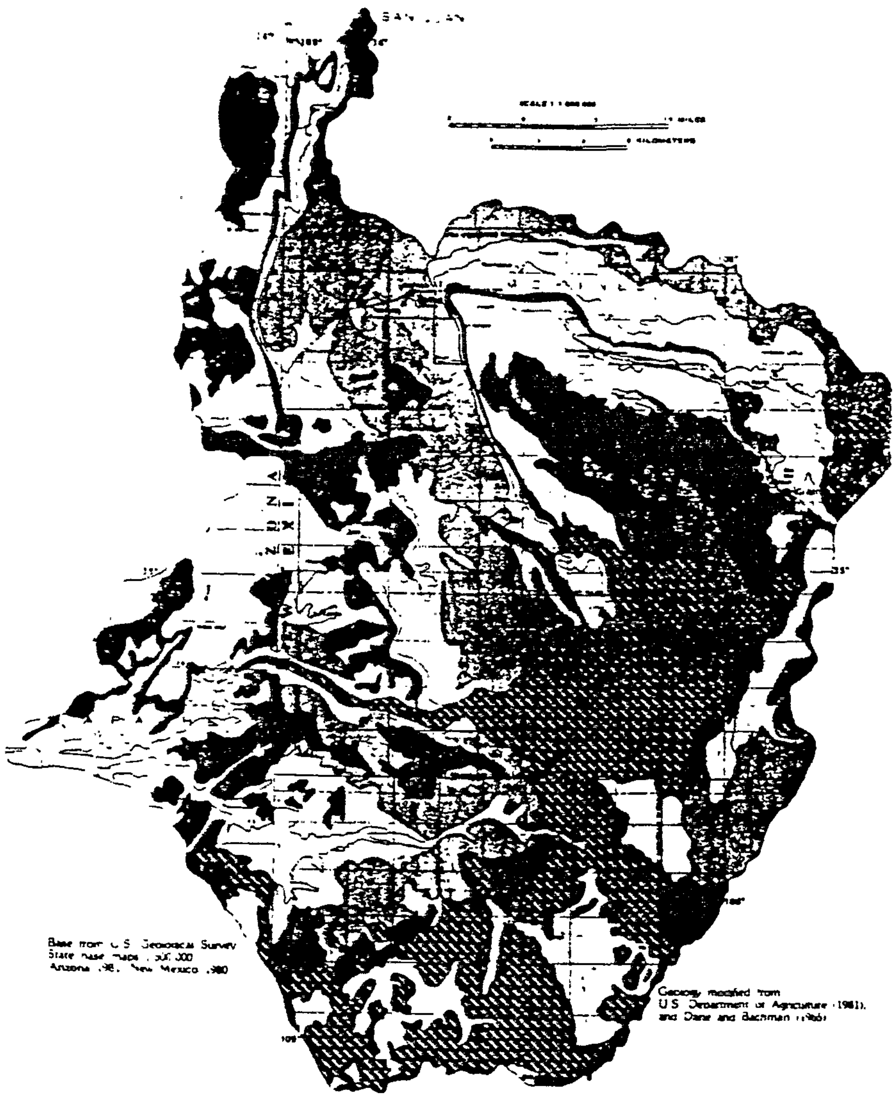


Figure 2.6-1 Generalized geologic map.

EXPLANATION

QUATERNARY AND TERTIARY	ALLUVIUM AND BOLSON DEPOSITS
	IGNEOUS ROCKS, INCLUDES BASALT FLOWS, VOLCANIC BRECCIA, TUFF AND CINDERS, AND EXPOSED INTRUSIVE IGNEOUS ROCKS
TERTIARY	SEDIMENTARY ROCKS INCLUDING BIDAHOCHI FORMATION, CHUSKA SANDSTONE, AND BACA FORMATION
CRETACEOUS	MESAVERDE GROUP
	MANCOS SHALE AND DAKOTA SANDSTONE, UNDIVIDED
JURASSIC	MORRISON FORMATION, ZUNI SANDSTONE, AND SAN RAFAEL GROUP, UNDIVIDED
JURASSIC AND TRIASSIC	GLEN CANYON GROUP
TRIASSIC	CHINLE FORMATION; LOCALLY INCLUDES MOENKOPI FORMATION
PERMIAN	SAN ANDRES LIMESTONE AND GLORIETA SANDSTONE IN NEW MEXICO, DE CHELLY SANDSTONE IN ARIZONA, AND THE YESO AND ABO FORMATIONS IN NEW MEXICO
PERMIAN AND PENNSYLVANIAN	SUPAI FORMATION
PRECAMBRIAN	PRECAMBRIAN ROCKS, UNDIVIDED

FIGURE = 3 ; REGIONAL GEOLOGY,
AFTER USGS, HYDROLOGY OF REGION 62

NAVAJO SUPERFUND OFFICE

NAVAJO-BROWN VANDEVER URANIUM MINE

JUNE, '90 P. MOLLOY

annual discharge rate of 2.97 cfs (20). The regional 1-yr, 24-hr rainfall event for the locale is 1.26 inches (13). Radioactive and toxic heavy metal species have been shown to be mobile in surface waters (23 throught 29). In particular, Arsenic and Selenium are known to sorb strongly to surface water sediments (26,28). The possibility exists for contaminated sediments to have been carried by flash floods, over the decades, onto the Alluvial plain east of El Tintero cinder cone (figure #2,7). A slight possiblilty exists for contaminated sediments to have been carried into Bluewater creek and the Rio San Jose (5,7). The area has not been mapped in a flood plain, However, due to the arid nature of the upgradient terrain and the general topography, the locale is prone to flash flooding events. Moreover, Haystack Mountain is very likely to be a recharge zone for aquifers in the area (5;pg#38).

D. ON SITE PATHWAY

As with other mines in the area the proto-ore was abandoned on-site. In the case of the Brown Vandever Mine, some of it was used to pave a haulage road which is used by site residents frequently (3;frame#22). The Brown Vandever mine environs are readily accessible by site residents and visitors to the area (3). There are no access barriers or danger signs on or near the mine site (3). Direct contact with contaminated particulates is possible during periods of high winds or physical disturbance of the tailings material. Humans living on-site and visitors to the area would are at risk to exposure from the same suite of radiospecies and heavy metals detailed above. Moreover, the ventilation shafts, the almost vertical timbered shaft and the inclined adits pose physical danger immediately dangerous to life and health status.

5. TARGETS

GROUND WATER TARGETS. There are three active wells within the 4 mile radius of influence of the site (19,21). The Indian Health Service (IHS) completed installation of a community Water System in October 1986 (21). Subsequent to the completion of the water system, operation and maintenance of the system was turned over to the Navajo Nation and is currently under the purvue of NNWRD (19). The community water system utilizes well #16T-551 which was formerly a livestock water well. The water system serves approximately 430 persons in the Haystack area (4;worksheet #2). Total population within the four mile radius of influence of the site was estimated to be approximately 500 (4;worksheet#2): The percentage of area residents not connected to the NNWRD water system was estimated to be 23% (=100 persons) on the basis of a residence count and the fact that 43.8% of Indian homes had their source of water more than 100 yds from their residennce (3,18,31). Area residents too indigent to afford plumbing and sewerage systems for their residences might utilize water from the active NNWRD stockwells #16T-522 and # 16T-521 (19,3;frame#41,18;pg.#1). In addition, there is at least 1 artesian spring in the immediate vicinity of the site (7;Bluewater Quad, 3;frame #35). There is a slight possibility that this spring could be utilized for drinking water.

The Aquifer of concern in the area is the Entrada sandstone unit which sources windmills possibly utilized for potable water by as many as 100 persons (4;worksheet#2,18;pg.#1,3;frame#41). Depth to the water table in this confined unit is reported to be approximately 400 feet (19). As pointed out before, the shaft and inclines have been driven to within 100 feet of this aquifer. Targets in the area consuming groundwater from the Entrada sandstone unit are at risk to exposure from Radionucleides and heavy metals (II).

SURFACE WATER TARGETS Surface water targets would be potentially exposed to the same suite of Radionucleides and heavy metals that is the case with ground water targets. Risk of exposure may be low due to the low value for net precipitation for the area. However, extreme conditions brought in the area would inundate the highly eroded haulage road (18).

The well-defined drainage coursing first east and then southeast from the site crosses at least one federally designated wetland (9).

AIR TARGETS Humans living on site are being exposed to elevated Radon concentrations.

ON-SITE TARGETS In addition to being exposed to elevated Radon concentrations, residents of the Brown Vandever mine environs are confronted daily with the dangerous inclines, shafts and the insult to their land.

SENSITIVE ENVIRONMENTS At least one federally designated sensitive environment lies within 1 mile of the site.

6. OTHER REGULATORY INVOLVEMENT

PERMITS: No permit was found for the Brown Vandever Uranium mine

STATE AGENCIES: None

OTHER FEDERAL PROGRAMS: None

7. CONCLUSIONS AND RECOMMENDATIONS

The Brown Vandever Uranium mine site is exceptionally dangerous. However, no steps toward remediation or mitigation have been undertaken over the two and one half decades since cessation of activities. To assert that residents of the site have not been adversely affected by the insult to their land and very possibly their health is inadmissable.

Immediate action should be taken.

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NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 3

P. ANTONIO MARCH'92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

December 23, 1991

MEMORANDUM

SUBJECT: Post Removal Soil Data, Bluewater Uranium Mine Sites

FROM: Robert Bornstein RB
Federal On-Scene-Coordinator

TO: Bluewater Interagency Committee

Enclosed for your review are the post removal soil sampling data collected at the Bluewater Uranium Mine Sites. During the week of September 15, 1991, ten composite samples were collected from the Bluewater Uranium Mine Sites. The composite samples were analyzed for Uranium isotopes and Radium 226 at the USEPA National Air and Radiation Environmental Lab located in Montgomery, Alabama.

BROWN-VANDEVER-NANABAH: Section 24, T13N, R11W

In order to collect the composite samples, the reclamated zone was subdivided into three areas: BV24A, BV24B, BV24C. Using a 45'X 50' grid (total 45 samples per section), samplers collected five tablespoon surface samples along the grid and placed them into a mixing bucket. After completing the sampling, the bucket was thoroughly mixed and a composite sample of one kilogram was collected and transferred into a zip lock bag. A background composite sample, BV24D, was collected by selecting 45 random samples from undisturbed portions of Section 24. See figure A.

BROWN-VANDEVER: Section 18, T13N, R10W

Two samples were collected within Section 18. A total of 45 samples were collected within the reclamated area. These samples were well mixed and a 1 Kg composit sample was drawn (BV18A). In addition, a random composite background sample was collected along the perimeter of the reclamated area in undisturbed areas (BV18B). See figure B.

DESIDERIO MINE SITE: Section 26, T 13N, R 10W

The Desiderio Mine Site area was subdivided into three equal sections. A 45'X 100'grid (total of 45 samples per section) was used to collect five tablespoon surface samples. The samples were placed into a mixing bucket and a 1 Kg composite sample was withdrawn. A random composite background sample was collected from non-disturbed areas around Section 26. See figure C.

DISCUSSION

The soil sampling data reveals that the reclamation action has successfully reduced any potential surface radiological hazard at these sites. The data shows that background conditions within the mine sites are not significantly lower than those detected within the reclamated areas. No sample exceeded the regulatory standard of 5 pCi/g over background pursuant to 40 CFR Section 192.

In general, the Radium 226 levels recorded within the reclamated zones are not uncommon to the natural Radium 226 concentrations detected within the Grants Mining District. Background Radium 226 concentrations in Milan, New Mexico (approximately 15 miles SE of the sites) have been reported by the Office of Radiation Programs[(1)] to be as high as 6.2 pCi/g. Background concentrations of Radium 226 of 2.2 pCi/g and 3.3 pCi/g were detected outside of San Mateo, New Mexico and within unmined areas of Ambrosia Lake.

Attached for your review is a copy of the Risk Assessment data generated by Steve Dean, Office of Air and Radiation, using sample BV24A. This sample was selected since it recorded the highest uranium and radium 226 content. The Assessment took into account all four possible pathways from soil exposure; ingestion, particulate inhalation, volatiles, and external gamma. The exposure scenario of eight (8) hours per day, 50 weeks per year for one year was used. Based on this scenario and a sample concentration of total uranium at 7.0 pCi/g and Radium 226 at 3.7 pCi/g (these samples include their respective background), the combined total risk from both metals for this sample is 3.0 in 10 million (3.0×10^{-7}). Using a Superfund residence scenario of thirty years, the total risk factor is 9 in 1 million excess cancer risk (9.0×10^{-6}).

Overall, the risk factor for the other samples are well below these figures. This risk calculation is a worst case scenario using the highest sample data. Risk associated with the natural conditions documented in the OAR Report[(1)] are also within the same risk factor or greater than those calculated for the BV24A sample. EPA uses the 10^{-6} risk value as a "point of departure" when selecting clean-up levels for National Priorities List Sites (40 CFR Section 300.430).

[1] "Report of Ambient Outdoor Radon and Indoor Radon Progeny Concentrations During November 1975 At Selected Locations in the Grants Mineral Belt, New Mexico," Office of Radiation Programs, Las Vegas, NV., June 1976, Report # OAR/LV-76-4: USDC NTIS PB-258-257.

CONCLUSIONS

In conclusion, the reclamation action undertaken by EPA has significantly reduced the radiological hazards associated with the mining wastes at the Bluewater Uranium Mine Sites. Both gamma radiation and radionuclide concentrations at the sites have been reduced to "natural" or background conditions. As documented in the OAR report referenced above, it is not uncommon to find natural Radium 226 readings higher within the Grants Mining District than those detected within our samples. The EPA response team to Bluewater believes that these sites no longer pose any immediate health hazard to the local public or wildlife. As a safeguard, further radiological testing and monitoring should be performed prior to any residential structures being constructed on the Sites.

If you have any questions or concerns, please contact me at 415-744-2298 (FTS 484-2298).

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

December 20, 1991

MEMORANDUM

SUBJECT: Bluewater Uranium Mine Site Soil Samples Data

FROM: Steve M. Dean SMDean
Environmental Scientist, (A-1-1)

TO: Robert Bornstein
Environmental Scientist, (H-8-3)

Listed below are the total uranium and radium 226 results for the 10 composite soil samples collected from the Bluewater Uranium Mine Site. The values listed are in picoCuries per gram (pCi/g) for dry weight of soil:

SAMPLE ID	Total Uranium	Radium 226
BV24A	7.0	3.7
BV24B	3.6	3.2
BV24C	3.2	2.9
BV24D (Background)	0.55/0.64*	0.73/0.90*
BV18A	1.5	0.94
BV18B (Background)	0.97	0.93
DES1	2.9	1.8
DES2	3.5	3.6
DES3	2.3	1.7
DES4 (Background)	2.2	2.4

* Analysed twice as a duplicate sample.

Since Sample BV24A was the highest in uranium and radium 226, I used its concentrations to perform a soil exposure risk assessment using Superfund's Risk Assessment Guidance, Human Health Evaluation Manual Part B. This assessment took into account all four possible pathways from soil exposure; ingestion, particulate inhalation, volatiles, and external gamma. I also used an exposure scenario of 8 hours per day, 50 weeks per year for one year. Based on the above concentrations and this scenario, the total risk for uranium is 1.6

RADIONUCLIDE RISK ASSESSMENT
in CONTAMINATED SOIL

```
RADIONUCLIDE OF CONCERN? u234
ENTER THE INGESTION SLOPE FACTOR? 1.4E-10
NOW ENTER THE INHALATION SLOPE FACTOR? 2.7E-8
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 5.7E-14
ENTER RADIONUCLIDE CONCENTRATION (in pCi/gram)? 3.385
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 4.730863E-12
VOLATILE RISK = 1.892345E-27
PARTICULATES RISK = 3.639125E-14
EXTERNAL EXPOSURE RISK = 1.804036E-08
TOTAL RISK = 1.804513E-08

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

1LIST   2RUN   3LOAD"   4SAVE"   5CONT   6,"LPT1  7TRON   8TROFF  9KEY    0SCREEN
```

SAMPLE BV24 A.

RADIONUCLIDE RISK ASSESSMENT
in CONTAMINATED SOIL

SAMPLE BV24A.

RADIONUCLIDE OF CONCERN? U235
ENTER THE INGESTION SLOPE FACTOR? 1.3E-10
NOW ENTER THE INHALATION SLOPE FACTOR? 2.5E-8
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 9.6E-12
ENTER RADIONUCLIDE CONCENTRATION (in pCi/gram)? .1388
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 3.267138E-11
VOLATILE RISK = 1.306855E-26
PARTICULATES RISK = 2.513183E-13
EXTERNAL EXPOSURE RISK = 1.245869E-07
TOTAL RISK = 1.246198E-07

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

1LIST 2RUN 3LOAD" 4SAVE" 5CONT 6,"LPT1 7TRON 8TROFF 9KEY 0SCREEN

RADIONUCLIDE RISK ASSESSMENT
in CONTAMINATED SOIL

SAMPLE BV24 A.

```
RADIONUCLIDE OF CONCERN? U238
ENTER THE INGESTION SLOPE FACTOR? 1.3E-10
NOW ENTER THE INHALATION SLOPE FACTOR? 2.4E-8
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 4.6E-14
ENTER RADIONUCLIDE CONCENTRATION (in pCi/gram)? 3.524
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 3.974666E-12
VOLATILE RISK = 1.589866E-27
PARTICULATES RISK = 3.057435E-14
EXTERNAL EXPOSURE RISK = 1.515672E-08
TOTAL RISK = 1.516073E-08

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

1LIST   2RUN   3LOAD"   4SAVE"   5CONT   6,"LPT1  7TRON   8TROFF  9KEY    0SCREEN
```

RADIONUCLIDE RISK ASSESSMENT
in CONTAMINATED SOIL

SAMPLE BV24A.

RADIONUCLIDE OF CONCERN? RA226
ENTER THE INGESTION SLOPE FACTOR? 1.2e-10
NOW ENTER THE INHALATION SLOPE FACTOR? 3e-9
ENTER THE EXTERNAL EXPOSURE SLOPE FACTOR? 4.2e-13
ENTER RADIONUCLIDE CONCENTRATION (in pCi/gram)? 3.7
NUMBER OF HOURS PER DAY OF EXPOSURE? 8
ENTER NUMBER OF WEEKS PER YEAR OF EXPOSURE? 50
ENTER NUMBER OF YEARS OF EXPOSURE? 1
INGESTION RISK = 3.810288E-11
VOLATILE RISK = 1.524116E-26
PARTICULATES RISK = 2.930991E-13
EXTERNAL EXPOSURE RISK = 1.45299E-07
TOTAL RISK = 1.453374E-07

PRESS S FOR RECALCULATING THE SAME RADIONUCLIDE?

1LIST 2RUN 3LOAD" 4SAVE" 5CONT 6,"LPT1 7TRON 8TROFF 9KEY 0SCREEN in 10 million and total risk for radium 226 is 1.4 in 10 million. Combined total risk from both metals at this location, (BV24A), is 3.0 in 10 million.

I hope this information is useful to you, if you have any questions or need any further assistance please contact me at X4-1049. Thank you.

Attachments

cc: Mike Bandrowski, (A-1-1)

*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:25 by CRIKNG.

Sample Id: R98 91.07507 BU24A

Counting system	AS 1 - Shelf A	Prep Date	11/26/91
Date, Time counted	11/27/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.213		
Sample size	0.5201 GASH		
Factor # 1	0.9370 GWET		
Factor # 2	0.9820 GDRY		

Gross cnts: Isotope		Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	884.	6.	3.447E+00	5.535E-02	11.34%	3.909E-01
U-235	36.	0.	1.413E-01	1.064E-02	34.55%	4.883E-02
U-238	917.	3.	3.588E+00	4.226E-02	11.25%	4.035E-01

TOTAL U 7.2

Gross cnts: Isotope		Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	884.	6.	3.230E+00	5.535E-02	11.34%	3.662E-01
U-235	36.	0.	1.324E-01	1.064E-02	34.55%	4.575E-02
U-238	917.	3.	3.362E+00	4.226E-02	11.25%	3.781E-01

TOTAL U 6.7

Gross cnts: Isotope		Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	884.	6.	3.385E+00	5.535E-02	11.34%	3.838E-01
U-235	36.	0.	1.388E-01	1.064E-02	34.55%	4.795E-02
U-238	917.	3.	3.524E+00	4.226E-02	11.25%	3.963E-01

TOTAL U 7.0

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******** Recalculated and Written To Database ********
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*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:26 by CRIKNG.

Sample Id: R95 91.07508 BV248

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Counting system	AS 2 - Shelf A		Prep Date	11/26/91
Date, Time counted	11/27/91 14:05		Bkg Date	11/22/91
Type Analysis	U prep by AS		Eff Date	12/19/90
Length of count	1000.0 Min		Std Date	10/09/91
Detector efficiency	0.206			
Sample size	0.5025 GASH			
Factor # 1	0.9430 GWET			
Factor # 2	0.9540 GDRY			

Gross cnts:	Isotope	Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	424.	5.	1.879E+00	5.878E-02	13.63%	2.560E-01
U-235	17.	1.	7.175E-02	3.300E-02	53.86%	3.864E-02
U-238	406.	4.	1.803E+00	5.385E-02	13.76%	2.481E-01

TOTAL U 3.8

Gross cnts:	Isotope	Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	424.	5.	1.772E+00	5.878E-02	13.63%	2.414E-01
U-235	17.	1.	6.766E-02	3.300E-02	53.86%	3.644E-02
U-238	406.	4.	1.700E+00	5.385E-02	13.76%	2.340E-01

TOTAL U 3.5

Gross cnts:	Isotope	Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	424.	5.	1.792E+00	5.878E-02	13.63%	2.443E-01
U-235	17.	1.	6.845E-02	3.300E-02	53.86%	3.686E-02
U-238	406.	4.	1.720E+00	5.385E-02	13.76%	2.367E-01

TOTAL U 3.6

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******** Recalculated and Written To Database ********
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... Uranium Calculations from Program Asu ***

This listing was created 12/04/91 at 07:46 by CRIKNG.

Sample Id: R98 91.07509 BV24C

Counting system	AS 1 - Shelf A	Prep Date	11/26/91
Date, Time counted	12/02/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.213		
Sample size	0.5170 GASH		
Factor # 1	0.9558 GWET		
Factor # 2	0.9880 GDRY		

Gross cnts: Isotope		Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	375.	5.	1.566E+00	5.549E-02	14.01%	2.194E-01
U-235	19.	0.	8.043E-02	1.147E-02	46.80%	3.764E-02
U-238	375.	2.	1.579E+00	3.931E-02	13.92%	2.197E-01

TOTAL U 3.2

Gross cnts: Isotope		Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	375.	5.	1.497E+00	5.549E-02	14.01%	2.097E-01
U-235	19.	0.	7.688E-02	1.147E-02	46.80%	3.598E-02
U-238	375.	2.	1.509E+00	3.931E-02	13.92%	2.100E-01

TOTAL U 3.1

Gross cnts: Isotope		Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	375.	5.	1.547E+00	5.549E-02	14.01%	2.168E-01
U-235	19.	0.	7.947E-02	1.147E-02	46.80%	3.719E-02
U-238	375.	2.	1.560E+00	3.931E-02	13.92%	2.171E-01

TOTAL U 3.2

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******** Recalculated and Written To Database ********

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*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:29 by CRIKNG.

Sample Id:	R95 91.07510 BV24D		
ounting system	AS 4 - Shelf A		
ate, Time counted	11/27/91 14:05	Prep Date	11/26/91
ype Analysis	U prep by AS	Bkg Date	11/22/91
ength of count	1000.0 Min	Eff Date	12/19/90
etector efficiency	0.236	Std Date	10/09/91
ample size	0.5073 GASH		
actor # 1	0.9560 GWET		
actor # 2	0.9800 GDRY		

Ω/1/KS

ross cnts: Isotope		Bkg	PCI/GASH		MDA	2 Sigma error in %	Absolute
U-234	94.	20.	2.834E-01		9.001E-02	30.15%	8.544E-02
U-235	3.	2.	3.830E-03	=<MDA	3.556E-02	447.30%	1.713E-02
U-238	71.	0.	2.719E-01		1.038E-02	25.29%	6.877E-02

TOTAL U 0.56

ross cnts: Isotope		Bkg	PCI/GWET		MDA	2 Sigma error in %	Absolute
U-234	94.	20.	2.709E-01		9.001E-02	30.15%	8.168E-02
U-235	3.	2.	3.661E-03	=<MDA	3.556E-02	447.30%	1.638E-02
U-238	71.	~~0.~~	2.599E-01		1.038E-02	25.29%	6.574E-02

TOTAL U 0.53

ross cnts: Isotope		Bkg	PCI/GDRY		MDA	2 Sigma error in %	Absolute
U-234	94.	20.	2.777E-01		9.001E-02	30.15%	8.373E-02
U-235	3.	2.	3.753E-03	=<MDA	3.556E-02	447.30%	1.679E-02
U-238	71.	0.	2.665E-01		1.038E-02	25.29%	6.739E-02

TOTAL U 0.55

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****** Recalculated and Written To Database ********

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*** Manual Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:29 by CRIKNG.

Sample Id: R9S 91.07510X BV24D

Counting system	AS 5 - Shelf A	Prep Date	11/26/91
Date, Time counted	11/27/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.206		
Sample size	0.5094 GASH		
Factor # 1	0.9560 GWET		
Factor # 2	0.9800 GDRY		

Isotope	Gross cnts:	Bkg	PCI/GASH		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	62.	7.	2.460E-01		6.714E-02	31.64%	7.781E-02
U-235	1.	0.	4.472E-03	=<MDA	1.212E-02	200.22%	8.954E-03
U-238	91.	1.	4.025E-01		3.291E-02	23.30%	9.377E-02

TOTAL U 0.65

Isotope	Gross cnts:	Bkg	PCI/GWET		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	62.	7.	2.351E-01		6.714E-02	31.64%	7.439E-02
U-235	1.	0.	4.275E-03	=<MDA	1.212E-02	200.22%	8.560E-03
U-238	91.	1.	3.848E-01		3.291E-02	23.30%	8.964E-02

TOTAL U 0.62

Isotope	Gross cnts:	Bkg	PCI/GDRY		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	62.	7.	2.410E-01		6.714E-02	31.64%	7.626E-02
U-235	1.	0.	4.383E-03	=<MDA	1.212E-02	200.22%	8.775E-03
U-238	91.	1.	3.944E-01		3.291E-02	23.30%	9.189E-02

TOTAL U 0.64

****

******** Recalculated and Written To Database ********

****

*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/04/91 at 07:47 by CRIKNG.

Sample Id: R95 91.07511 BV18A

Counting system	AS 2 - Shelf A	Prep Date	11/26/91
Date, Time counted	12/02/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.206		
Sample size	0.5130 GASH		
Factor # 1	0.9730 GWET		
Factor # 2	0.9958 GDRY		

Isotope	Gross cnts	Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	180.	4.	7.534E-01	5.141E-02	18.01%	1.357E-01
U-235	13.	0.	5.565E-02	1.160E-02	56.25%	3.130E-02
U-238	158.	3.	6.635E-01	4.608E-02	18.84%	1.250E-01

TOTAL U 1.5

Isotope	Gross cnts	Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	180.	4.	7.330E-01	5.141E-02	18.01%	1.320E-01
U-235	13.	0.	5.414E-02	1.160E-02	56.25%	3.046E-02
U-238	158.	3.	6.456E-01	4.608E-02	18.84%	1.216E-01

TOTAL U 1.4

Isotope	Gross cnts	Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	180.	4.	7.502E-01	5.141E-02	18.01%	1.351E-01
U-235	13.	0.	5.541E-02	1.160E-02	56.25%	3.117E-02
U-238	158.	3.	6.607E-01	4.608E-02	18.84%	1.245E-01

TOTAL U 1.5

****
******* Recalculated and Written To Database ********
****

*** MANUAL Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:30 by CRIKNG.

Sample Id: R98 91.07512 BV18B

Counting system	AS 7 - Shelf A	Prep Date	11/26/91
Date, Time counted	11/27/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.211		
Sample size	0.5064 GASH		
Factor # 1	0.9540 GWET		
Factor # 2	0.9840 GDRY		

BV1

Gross cnts: Isotope		Bkg	PCI/GASH		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	113.	5.	5.042E-01		6.119E-02	22.22%	1.120E-01
U-235	2.	2.	0.000E+00	=<MDA	4.335E-02	0.00%	1.867E-02
U-238	104.	1.	4.808E-01		3.436E-02	22.02%	1.059E-01

TOTAL U 0.98

Gross cnts: Isotope		Bkg	PCI/GWET		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	113.	5.	4.810E-01		6.119E-02	22.22%	1.069E-01
U-235	2.	2.	0.000E+00	=<MDA	4.335E-02	0.00%	1.781E-02
U-238	104.	1.	4.587E-01		3.436E-02	22.02%	1.010E-01

TOTAL U 0.94

Gross cnts: Isotope		Bkg	PCI/GDRY		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	113.	5.	4.961E-01		6.119E-02	22.22%	1.102E-01
U-235	2.	2.	0.000E+00	=<MDA	4.335E-02	0.00%	1.837E-02
U-238	104.	1.	4.731E-01		3.436E-02	22.02%	1.042E-01

TOTAL U 0.97

****
******** Recalculated and Written To Database ********
****

This listing was created 12/04/91 at 12:56 by CKIKNG.

Sample Id: R9S 91.07513 DES1

Counting system	AS 3 - Shelf A	Prep Date	11/26/91
Date, Time counted	12/02/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.251		
Sample size	0.5073 GASH		
Factor # 1	0.8890 GWET		
Factor # 2	0.9074 GDRY		

Gross cnts: Isotope		Bkg	PCI/GASH	MDA	2 Sigma error in %	Absolute
U-234	406.	9.	1.578E+00	6.622E-02	13.44%	2.122E-01
U-235	17.	2.	5.963E-02	3.691E-02	58.76%	3.504E-02
U-238	386.	0.	1.534E+00	1.077E-02	13.38%	2.053E-01

TOTAL U 3.2

Gross cnts: Isotope		Bkg	PCI/GWET	MDA	2 Sigma error in %	Absolute
U-234	406.	9.	1.403E+00	6.622E-02	13.44%	1.886E-01
U-235	17.	2.	5.301E-02	3.691E-02	58.76%	3.115E-02
U-238	386.	0.	1.364E+00	1.077E-02	13.38%	1.825E-01

TOTAL U 2.8

Gross cnts: Isotope		Bkg	PCI/GDRY	MDA	2 Sigma error in %	Absolute
U-234	406.	9.	1.432E+00	6.622E-02	13.44%	1.925E-01
U-235	17.	2.	5.410E-02	3.691E-02	58.76%	3.179E-02
U-238	386.	0.	1.392E+00	1.077E-02	13.38%	1.863E-01

TOTAL U 2.9

****
******* Recalculated and Written To Database ********
****

*** Manual Uranium Calculations from Program Asu ***

This listing was created 12/03/91 at 08:22 by CRIKNG.

Sample Id:	R9S 91.07514 DES2		
Counting system	AS 8 - Shelf A	Prep Date	11/26/91
Date, Time counted	11/29/91 12:33	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.208		
Sample size	0.5000 GASH		
Factor # 1	0.9669 GWET		
Factor # 2	0.9871 GDRY		

Gross cnts:	Isotope	Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	396.	9.	1.683E+00	7.246E-02	13.94%	2.346E-01
U-235	34.	0.	1.479E-01	1.179E-02	35.53%	5.254E-02
U-238	388.	3.	1.675E+00	4.682E-02	13.84%	2.317E-01

TOTAL U 3.5

Gross cnts:	Isotope	Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	396.	9.	1.628E+00	7.246E-02	13.94%	2.268E-01
U-235	34.	0.	1.430E-01	1.179E-02	35.53%	5.081E-02
U-238	388.	3.	1.619E+00	4.682E-02	13.84%	2.241E-01

TOTAL U 3.4

Gross cnts:	Isotope	Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	396.	9.	1.662E+00	7.246E-02	13.94%	2.315E-01
U-235	34.	0.	1.460E-01	1.179E-02	35.53%	5.187E-02
U-238	388.	3.	1.653E+00	4.682E-02	13.84%	2.288E-01

TOTAL U 3.5

****
******* Recalculated and Written To Database ********
****

... Calc ations from Program Asu ***

This listing was created 12/04/91 at 07:49 by CRIKNG.

Sample Id: R95 91.07515 DES3

Counting system	AS 4 - Shelf A	Prep Date	11/26/91
Date, Time counted	12/02/91 14:05	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.236		
Sample size	0.5012 GASH		
Factor # 1	0.6123 GWET		
Factor # 2	0.9800 GDRY		

Gross cnts:	Isotope	Bkg	PCI/GASH		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	229.	7.	1.210E+00		8.184E-02	16.83%	2.036E-01
U-235	11.	4.	3.816E-02	=<MDA	6.547E-02	111.07%	4.238E-02
U-238	202.	2.	1.090E+00		5.062E-02	17.19%	1.874E-01

TOTAL U 2.3

Gross cnts:	Isotope	Bkg	PCI/GWET		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	229.	7.	7.410E-01		8.184E-02	16.83%	1.247E-01
U-235	11.	4.	2.336E-02	=<MDA	6.547E-02	111.07%	2.595E-02
U-238	202.	2.	6.675E-01		5.062E-02	17.19%	1.148E-01

TOTAL U 1.4

Gross cnts:	Isotope	Bkg	PCI/GDRY		MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	229.	7.	1.186E+00		8.184E-02	16.83%	1.995E-01
U-235	11.	4.	3.739E-02	=<MDA	6.547E-02	111.07%	4.153E-02
U-238	202.	2.	1.068E+00		5.062E-02	17.19%	1.837E-01

TOTAL U 2.3

****
********   Recalculated and Written To Database   ********
****

This listing was create 12/03/91 at 08:23 by CHIK

Sample Id: R9S 91.07516 D6S4

Counting system	AS 9 - Shelf A	Prep Date	11/26/91
Date, Time counted	11/29/91 12:33	Bkg Date	11/22/91
Type Analysis	U prep by AS	Eff Date	12/19/90
Length of count	1000.0 Min	Std Date	10/09/91
Detector efficiency	0.213		
Sample size	0.5043 GASH		
Factor # 1	0.9469 GWET		
Factor # 2	0.9642 GDRY		

Gross cnts: Isotope		Bkg	PCI/GASH	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	307.	7.	1.137E+00	5.665E-02	14.81%	1.676E-01
U-235	19.	0.	7.169E-02	1.023E-02	46.74%	3.351E-02
U-238	303.	3.	1.137E+00	4.062E-02	14.69%	1.663E-01

TOTAL U 2.3

Gross cnts: Isotope		Bkg	PCI/GWET	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	307.	7.	1.072E+00	5.665E-02	14.81%	1.587E-01
U-235	19.	0.	6.789E-02	1.023E-02	46.74%	3.173E-02
U-238	303.	3.	1.072E+00	4.062E-02	14.69%	1.574E-01

TOTAL U 2.2

Gross cnts: Isotope		Bkg	PCI/GDRY	MDA	2 Sigma error in %	2 Sigma error Absolute
U-234	307.	7.	1.091E+00	5.665E-02	14.81%	1.616E-01
U-235	19.	0.	6.913E-02	1.023E-02	46.74%	3.231E-02
U-238	303.	3.	1.091E+00	4.062E-02	14.69%	1.603E-01

TOTAL U 2.2

****
******** Recalculated and Written To Database ********
****

Sample ID	R95 91,07507
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV24A
Comments	BLUEWATER U MINE SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	3.7700E+00	2.20 %	PCI/GASH	9/19/91
RA-226	3.5300E+00	2.20 %	PCI/GWET	9/19/91
RA-226	3.7000E+00	2.20 %	PCI/GDRY	9/19/91

Sample ID	R95 91,07508
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV24B
Comments	BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	3.2600E+00	2.36 %	PCI/GASH	9/19/91
RA-226	3.0700E+00	2.36 %	PCI/GWET	9/19/91
RA-226	3.2200E+00	2.36 %	PCI/GDRY	9/19/91

Sample ID	R95 91,07509
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV24C
Comments	BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	2.9500E+00	2.49 %	PCI/GASH	9/19/91
RA-226	2.8200E+00	2.49 %	PCI/GWET	9/19/91
RA-226	2.9100E+00	2.49 %	PCI/GDRY	9/19/91

Sample ID	R9S 91,07[illegible]0
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV24D
Comments	BLUEWATER MINING U SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	7.5000E-01	4.93 %	PCI/GASH	9/19/91
RA-226	7.2000E-01	4.93 %	PCI/GWET	9/19/91
RA-226	7.3000E-01	4.93 %	PCI/GDRY	9/19/91

Sample ID	R9S 91,07510X
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV24D
Comments	BLUEWATER MINING U SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	9.2000E-01	4.57 %	PCI/GASH	9/19/91
RA-226	8.8000E-01	4.57 %	PCI/GWET	9/19/91
RA-226	9.0000E-01	4.57 %	PCI/GDRY	9/19/91

Sample ID	R9S 91,07511
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV18A
Comments	BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	9.5000E-01	4.60 %	PCI/GASH	9/19/91
RA-226	9.2000E-01	4.60 %	PCI/GWET	9/19/91
RA-226	9.4000E-01	4.60 %	PCI/GDRY	9/19/91

Sample ID	R9S 91.07512
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	BV18B
Comments	BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	9.4000E-01	4.45 %	PCI/GASH	9/19/91
RA-226	9.0000E-01	4.45 %	PCI/GWET	9/19/91
RA-226	9.3000E-01	4.45 %	PCI/GDRY	9/19/91

Sample ID	R9S 91.07513
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	DES1
Comments	BLUEWATER U MINING SITES
Report to	GERRY LUSTER

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	2.0000E+00	3.21 %	PCI/GASH	9/19/91
RA-226	1.7800E+00	3.21 %	PCI/GWET	9/19/91
RA-226	1.8100E+00	3.21 %	PCI/GDRY	9/19/91

Sample ID	R9S 91.07514
Sample type	SOIL
Collection date, time	9/19/91 0:00
Location	NM:PREWITT
Other ID's	DES2
Comments	BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	3.6600E+00	2.26 %	PCI/GASH	9/19/91
RA-226	3.5300E+00	2.26 %	PCI/GWET	9/19/91
RA-226	3.6100E+00	2.26 %	PCI/GDRY	9/19/91

Sample ID R9S 91.07515
Sample type SOIL
Collection date, time 9/18/91 0:00
Location NM:PREWITT
Other ID's DES3
Comments BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

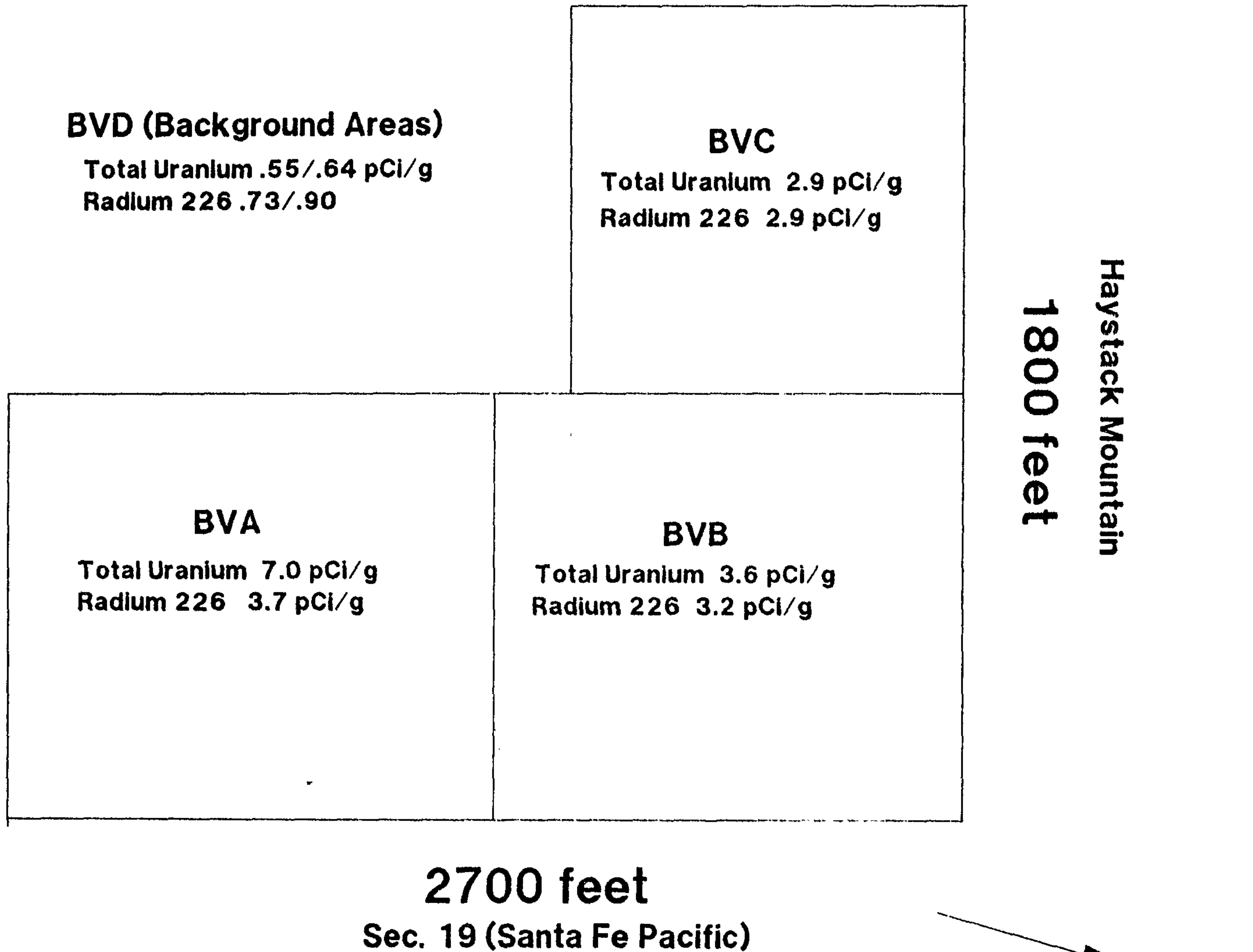
NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	1.8000E+00	3.38 %	PCI/GASH	9/19/91
RA-226	1.1000E+00	3.38 %	PCI/GWET	9/19/91
RA-226	1.7600E+00	3.38 %	PCI/GDRY	9/19/91

Sample ID R9S 91.07516
Sample type SOIL
Collection date, time 9/18/91 0:00
Location NM:PREWITT
Other ID's DES4
Comments BLUEWATER U MINING SITES

Type of analysis ********** RA226 **********

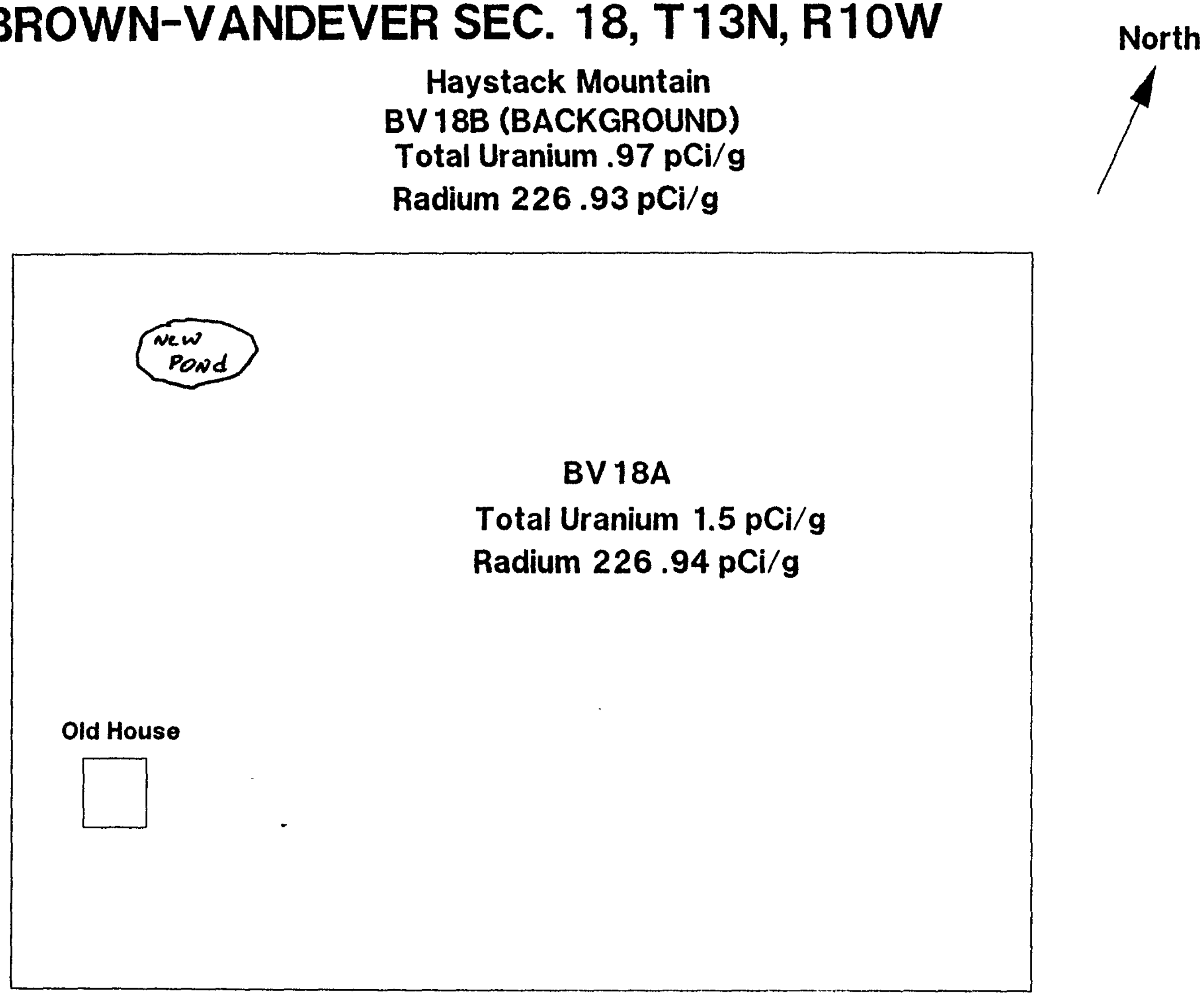
NUCLIDE	ACTIVITY	2 SIG ERROR	UNITS	DATE
RA-226	2.4700E+00	2.71 %	PCI/GASH	9/19/91
RA-226	2.3400F+00	2.71 %	PCI/GWET	9/19/91
RA-226	2.3800E+00	2.71 %	PCI/GDRY	9/19/91

POST REMOVAL URANIUM/RADIUM SOIL SAMPLING
BROWN-VANDEVER SEC. 24, T13N, R11W



Not to Scale
Figure A

POST REMOVAL URANIUM/RADIUM SOIL SAMPLING
BROWN-VANDEVER SEC. 18, T13N, R10W



NoT To Scale
Figure B

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 4

P. ANTONIO MARCH'92

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Rio Puerco Resource Area
435 Montano N.E.
Albuquerque, New Mexico 87107

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

3570 (017)

JUL 07 1988

RECEIVED
JUL 11 1988
Environmental Protection Commission
07-21-88
→ P.A.

The Navajo Nation
Attn: Louise Linkin, Navajo EPA
P.O. Box 308
Window Rock, AZ 86515

Dear Ms. Linkin:

At the request of Patrick Antonio, Roger Baer of my staff has prepared three work-maps for Patrick's use. These maps outline areas on Navajo allotted lands where the greatest possibility exists for finding residences which have high levels of radioactive radon-222 gas.

Uranium mineralization has historically been found in all rock layers between the Todilto Formation and the Dakota Formation in the area around Haystack Mountain. Where these formations outcrop on the surface, one can expect to find the greatest concentrations of uranium minerals. Residences built where these formation outcrop may have higher than normal to very high levels of radon gas.

We recommend that all residences located between the outcrop of the bottom of the Todilto and the top of Dakota be surveyed for radon gas. The areas of greatest concern are in T. 13 N., R. 10 W. and the northeast quarter of T. 13 N., R. 11 W. These areas are indicated on the enclosed maps.

If you have any questions, please contact John Andrews, Chief of the Minerals Staff at 505-761-4504.

Sincerely,

Herrick E. Hanks

Herrick E. Hanks
Rio Puerco Resource Area
Manager

Enclosures

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 5

P. ANTONIO MARCH'92

See Figure 1 of SI Report for information on the applicable U.S.G.S. Topographic Quad map.

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 6

P. ANTONIO MARCH'92

Uranium and Thorium Occurrences in New Mexico: Distribution, Geology, Production, and Resources, with Selected Bibliography

by

Virginia T. McLemore

New Mexico Bureau of Mines and Mineral Resources

Open-file Report OF-183

September, 1983

Partial Financial Support by
U.S. Department of Energy
Grand Junction Area Office
Subcontract No. 82-555-E

Number	Mine Name	Tons Ore	Pounds U_3O_8	$\%U_3O_8$	Pounds V_2O_5	$\%V_2O_5$	Type of Deposit	Host Rock	Periods of Production/ Shipper
15N.17W.33.214	Diamond #2 (Largo #2, Mike Smith Lease)	55,717	244,939	0.22	86,298	—	sandstone	Kd	1952-1953 - Adee Dodge Enterprises; 1954-1956-General Uranium; 1955,1956-1959-Largo Uranium Co.; 1964-1967-A and B Mining Co.; 1968-1970-Shiprock Ltd
13N.9W.20.411	[1]Dog, Flea, and BG Group	244,177	906,235	0.19	—	—	sandstone	Jmp	1957-1970 - Four Corners Exploration Co.
13N.9W.21.324	[1]Doris-Section 21	31,950	118,052	0.18	—	—	sandstone	Jmp	1958-1959 - Westvaco; 1959-1960-Phillips Petroleum Co. 1959-1961-Phillips Petroleu Co.; 1959-1961-Phillips Petroleum Co.-KSN Co.; 1961-KSN Co.
14N.10W.11.312	Dysart #1 (Section 11)	891,922	3,795,495	0.21	47,438	—	sandstone	Jmw	1956-1958 - Rio de Oro; 1959 1960-Midcontinent and Rio d Oro; 1961-Rio de Oro; 1961-1962-Homestake-Sapin
14N.10W.11.424	Dysart #2	237,602	894,642	0.19	—	—	sandstone	Jmw	1959 - Rio de Oro and Mid-continent; 1960-1961-Rio de Oro; 1961-1962-Homestake-Sapin
13N.9W.20.233	East Malpais Lease	30,333	139,818	0.23	—	—	sandstone	Jmp	1958-1960 - Four Corners Exploration Co.
14N.12W.24.243	Elkins Group	59	151	0.13	231	0.20	limestone	Jt	1952 - Farris Mines, Inc.; 1953-1954-Josephine Elkins
14N.11W.9.214	[1]Evelyn	10,743	49,584	0.23	23,539	0.48	sandstone	Jmb	1953-1956 - Anaconda Co.; 1966-1968-Farris Mines, Inc.; 1969-1970-Smith Development; 1970-Minerals Energy
13N.9W.29.141	Faith-Section 29	66,327	258,615	0.19	—	—	limestone	Jt	1958-1959 - Westvaco; 1959-1960-Phillips Petroleum Co.; 1960-Phillips Petroleum Co.-KSN Co.; 1961-1962-KSN Co.; 1963-United Nuclear; 1963-KSN Co. and United Nuclear; 1964-KSN Co.
13N.9W.30.442	Flat Top	49,663	216,486	0.22	66,126	0.11	limestone	Jt	1955-1957 - Holly Uranium Co.; 1957-1959-Flat Top Mining Co.; 1963-1966-Bailey and Fife
15N.16W.4.111	Foutz #1	324	1,844	0.28	2,676	0.41	sandstone	Jmw	1953 - Foutz Mining Co., Foutz Mining Co. and Hanosh Mines
15N.16W.5.222	Foutz #2	242	1,045	0.22	2,877	0.59	sandstone	Jmw	1953-1954 - Foutz Mining Co.
16N.16W.31.444	Foutz #3	2,412	8,556	0.18	12,466	0.26	sandstone	Jmb	1953-1955 - Foutz Mining Co.
14N.11W.8.213	Francis	755	6,164	0.41	12,578	0.93	sandstone	Jmb	1953-1954 - Farris Mines, Inc.
	[1]Haystack						limestone	Jt	1952-1965 - Haystack Mountain Development Corp.
13N.11W.13.314	SW1/4 sec. 13	1,162	2,830	0.12	—	—			
13N.11W.13.444	Bibo	3,736	16,701	0.22	—	—			
13N.10W.19.110	Sec. 19	137,310	562,267	0.20	165,454	—			
	TOTAL	142,208	581,798	0.20	165,494				
3N.9W.14.414	Hogan Mine (Section 14)	129,551	678,510	0.26	—	—	sandstone	Jmp	1959-1961 - Four Corners Exploration Co.; 1962-Homestake-Sapin
15N.18W.12.244	Hogback #3-5	6,354	24,234	0.19	2,954	0.03	shale	Kd	1951-1953 - Albert Smith; 1954-1956-Hyde Uranium Co.; 1957-1958-Calumet and Hecla; 1958-Mathis and Mathis; 1959-See Tee Mining Co.; 1960-Windsor Mining Co.
13N.9W.7.221	[1]Isabella (Section 7)	76,748	237,060	0.15	—	—	sandstone	Jmp	1959-1961 - Phillips Petroleum Co.; 1961-1962-KSN Mining Co.
4N.11W.35.120	Lost Mine	10	4	0.02	4	0.02	sandstone	Jmb	1954 - Berryhill and Elkins
5N.14W.12.423	[1]Mac #1	60,109	289,125	0.24	—	—	sandstone	Jmb	1968 - Homestake-Sapin; 1968-1970-United Nuclear-Homestake
5N.13W.18.442	Mac #2	31,194	109,009	0.14	—	—	sandstone	Jmb	1968 - Homestake-Sapin; 1968-1970-United Nuclear-Homestake
13N.9W.20.144	Malpais Raise	42,070	198,492	0.24	—	—	sandstone	Jmp	1958 - Holly Minerals; 1958-1961-See Tee Mining Group
13N.9W.23.233	Marquez Mine	723,032	3,757,847	0.26	—	—	sandstone	Jmp	1958-1964 - Calumet and Hecla; 1965-1966-United Nuclear Corp.
[illegible]N.10W.11.112	Mary #1 (Dysart #3)	357,262	794,063	0.11	—	—	sandstone	Jmw	1959-1961 - Boyles Brothers; 1962-Boyles Brothers and Entrada Corp.; 1964-Stella Dysart; 1964-Dysart and Homestake-Sapin; 1964-1965-Homestake-Sapin

Number	Mine Name	Tons Ore	Pounds U_3O_8	$\%U_3O_8$	Pounds V_2O_5	$\%V_2O_5$	Type of Deposit	Host Rock	Periods of Production/ Shipper
13N.9W.20.321	Mesa Top Mine	108,261	512,965	0.24	144,610	—	sandstone	Jmp	1954-1957 - Lea Exploration; 1957-Holly Minerals and Lea
..10W.4.244	Pat - Section 4 (Dakota Mine)	5,069	12,645	0.12	2,478	—	sandstone	Jmw,Kd	1952-1959 - Dakota Mining Co.; 1962-1963-Farris Mines, Inc.
13N.9W.19.420	[1]Poison Canyon	217,066	1,004,574	0.23	338,094	—	sandstone	Jmp	1952-1959 - Haystack Mountair Development Corp.; 1960-1962-Farris Mines Inc.
14N.11W.28.113	Red Cap Group (T Group)	195	497	0.13	951	0.24	limestone	Jt	1952-1953 - Navajo Development Co.; 1953-Fitzhugh & Doerrie
13N.10W.16.134	Red Point Lode	482	1,223	0.13	746	0.07	limestone	Jt	1952-1955 - R.M. Shaw
14N.11W.20.144	Red Top Mines	165	390	0.12	1,287	0.39	limestone	Jt	1955 - Red Top Uranium Mining Co.
14N.9W.34.424	[1]Sandstone	1,034,255	3,540,829	0.17	—	—	sandstone	Jmw	1959-1963 - Phillips Petroleum Co.; 1963-1970-United Nuclear Corp.
13N.9W.1.200	[1]Section 1 (13N-9W) mined through Cliffside	148,066	1,699,137	0.57	—	—	sandstone	Jmw	1967 - Kerr-McGee; 1969-1970-Kerr-McGee and Nation Lead
15N.16W.3.332	Section 3 (15N-16W) Santa Fe-Christensen Rats Nest Mine	324	1,836	0.28	404	—	sandstone (coal)	Kd	1957 - Christensen and Rem Uranium Co.; 1957-1958-Rem Uranium Co.
13N.10W.5.144	Section 5 (13N-10W)	23	54	0.12	—	—	sandstone	Kd	1958 - Westvaco
13N.9W.8.114	Section 8 (13N-9W) Spencer Shaft	47,800	165,319	0.17	—	—	sandstone	Jmp	1958-1960 - United Western; 1961-Hyde and Casper; 1964-1966-W.D. Tripp; 1966-1967-James J. Goode
14N.10W.10.244	[1]Section 10 (14N-10W)	130,767	510,935	0.20	—	—	sandstone	Jmw	1957-1962 - Kermac Nuclear; 1964-Homestake-Sapin
14N.10W.12.411	[1]Section 12 (14N-10W)	74,975	211,873	0.14	—	—	sandstone	Jmw	1961 - Anderson Development Corp.; 1962-1963-Stella Dysart
14N.10W.15.441	[1]Section 15 (14N-10W)	1,213,814	3,625,924	0.15	—	—	sandstone	Jmw	1958-1961 - Homestake-Sapin; 1961-1965-Rio and Homestake-Sapin; 1966-1969-Homestake-Sapin; 1969-1970-United Nuclear-Homestake
14N.9W.17.323	[1]Section 17 (14N-9W)	544,164	2,315,182	0.21	—	—	sandstone	Jmw	1960-1964 - Kermac Nuclear Corp.; 1965-1970-Kerr-McGee
13N.10W.18.341	Section 18 (13N-10W) (Indian Allotment)	25,796	98,175	0.19	75,342	0.30	limestone	Jt	1952 - Sutton, Thompson, Williams; 1953-Williams; 1955-Santa Fe Uranium; 1955-1956-Santa Fe Uranium and Federal Uranium; 1957-1959-Federal Uranium; 1963-1964-Mesa Mining Co.; 1966-Cibola Mining Co.
14N.9W.18.400	[1]Section 18 (14N-9W) mined through Sec. 17	501,946	1,586,447	0.16	—	—	sandstone	Jmw	1962-1964 - Kermac Nuclear; 1965-1970-Kerr-McGee
14N.9W.20.114	[1]Section 20 (14N.9W) mined through Sec. 17	486,375	2,223,977	0.23	—	—	sandstone	Jmw	1962 - Kerr-McGee
14N.10W.22.223	[1]Section 22 (14N-10W)	2,189,051	11,605,672	0.18	—	—	sandstone	Jmw	1958-1964 - Kermac Nuclear; 1965-1970-Kerr-McGee
	heap leach	—	38,105	—	—	—			
14N.10W.23.134	[1]Section 23 (14N-10W)	2,528,797	9,679,773	0.19	—	—	sandstone	Jmw	1959-1968 - Homestake-Sapin; 1969-1970-Homestake-United Nuclear
13N.10W.23.444	Section 23 (13N-10W)	21,826	138,541	0.32	10,256	0.06	limestone	Jt	1957-1965 - Haystack Mountain Development Corp.; 1965-1966-Santa Fe Pacific
13N.9W.24.121	Section 24 (13N-9W) Chill Wills, Rialto (Section 13)	10,950	37,693	0.17	—	—	sandstone	Jmp	1960-1963 - Febco Mines, Inc.
13N.11W.24.222	Section 24 (13N-11W) Indian Allotment to Nana-A-Bah Vandever	24,638	115,075	0.22	85,545	0.18	limestone	Jt	1952-1954 - Glen Williams; 1955-1956-Santa Fe Uranium; 1955-Federal Uranium Corp. Santa Fe Uranium; 1956-1957-Federal Uranium Corp.
14N.10W.24.332	[1]Section 24 (14N-10W)	1,904,582	7,071,564	0.19	—	—	sandstone	Jmw	1959-1964 - Kerr-McGee Nuclear; 1965-1970-Kerr-McGee
	Heap leach	—	579	—	—	—			
13N.10W.25.411	[1]Section 25 (13N-10W)	235,156	958,058	0.20	153,657	0.12	limestone	Jt	1952 - A T and SF RR; 1955-1961-Haystack Mountain Development Corp.; 1962-1963-Santa Fe Pacific; 1963-Farris Mines, Inc.; 1963-1965-Santa Fe Pacific; 1965-1966-Farris Mines, Inc.; 1968-Homestake; 1969-1970-United Nuclear Corp.
14N.10W.25.144	[1]Section 25 (14N-10W)	1,791,048	6,444,889	0.18	—	—	sandstone	Jmw	1959-1969 - Homestake-Sapin; 1969-1970-Homestake-United Nuclear
13N.10W.26.221	[1]Section 26 (13N-10W) Desidero Group	11,110	83,752	0.38	17,518	0.08	limestone	Jt	1952-1957 - Hanosh Mines
14N.10W.26.220	[1]Section 26 (14N-10W) mined through Section 24	362,110	1,198,696	0.17	—	—	sandstone	Jmw	1965-1970 - Kerr-McGee

Table 3-2: Uranium mines in New Mexico that have produced from 1970 to 1982 (U.S. Department of Energy files).

Occurrence Number	Mine Name	Production[1] Class	Host[2] Rock	Periods of Production/ Shipper
	Cibola County (formerly Valencia County)			
12N.9W.33.444	[3]F-33 (Section 33)	c	Jt	1954-1959 - Anaconda; 1971-1977-Homestake
11N.5W.26,35	[3]Jackpile-Paguate	e	Jmj	1952-1982 - Anaconda
11N.5W.13.300	JJ #1	d	Jmj	1976-1981 - Sohio-Reserve
13N.8W.24.433	Mt. Taylor	c	Jmw	1980-1982 - Gulf
12N.9W.4	[3]Red Bluff-Gay Eagle	b	Jt	1952-1965; 1976-Moises-Mirabel
11N.4W.19.300, 11N.4W.30.240, 11N.5W.24.411	[3]St. Anthony	b	Jmj	1953-1960; 1977-1982 - United Nuclear
13N.8W.30.243	[3]San Mateo Mine	d	Jmp	1959-1967 - Rare Metals Corp.; 1967-1971-United Nuclear
	McKinley County			
14N.9W.28.144	[3]Ann Lee (Spider Rock)	d	Jmw	1958-1963 - Phillips; 1963-1973, 1982-United Nuclear; 1977-1982-Spider Rock
13N.9W.30.221	[3]Barbara J #3 (White Cap)	c	Jt	1959-1963 - Midcontinent; 1979-1980-Todilto Exp. Dev. Co.
14N.11W.19.220	[3]Billy the Kid	a	Jt	1952-1960; 1976-Henry Andrews
15N.13W.12.322	[3]Black Jack #1	d	Jmw	1959-1969; 1969-1971-United Nuclear-Homestake
15N.13W.18.223	[3]Black Jack #2	c	Jmb	1959-1968; 1969-1970-United Nuclear-Homestake
14N.10W.14.414	[3]Buckey	c	Jmw	1957-1965; 1972-Hydro-Nuclear; 1978-1980, 1982-Cobb
16N.16W.17.212	[3]Church Rock (Sec. 8, 17)	c	Jmw, Jmb, Kd	1960-1962; 1976-1977, 1979-1982-United Nuclear
14N.9W.36.332	[3]Cliffside-Section 36	d	Jmw	1960-1968; 1970-present - Kerr-McGee
15N.17W.33.214	[3]Diamond #2	c	Kd	1952-1967; 1968-1970-Shiprock, Ltd.
13N.9W.20.411	[3]Dog, Flea, and BG Group	c	Jmp	1957-1975 - Four Corners Exp.; 1978-1980-M&M Mining
13N.9W.21.324	[3]Doris-Section 21	b	Jmp	1958-1961; 1978-1979-Ranchers
14N.11W.9.214	[3]Evelyn	b	Jmb	1953-1968, 1969-1970-Smith Dev.; 1970-Minerals Eng.; 1971-1972-Stevenson; 1972-Oral Creek
13N.11W.13.314	[3]Haystack-Section 13	c	Jt	1975-1981 - Todilto Exp. and Dev.
13N.10W.19.110	Section 18 and 19	c		
13N.9W.19.323	Hope (Section 19)	a or b	Jt	1977-1981 - Ranchers
13N.9W.7.221	[3]Isabella	c	Jmp	1959-1962; 1978-1980 - Koppin; 1980-United Nuclear
13N.8W.7, 18	Johnny M (Section 7)	d	Jmw	1976-1982 - Ranchers
15N.14W.12.423	[3]Mac #1	c	Jmb	1968; 1968-1970, 1976-1978, 1980 - United Nuclear-Homestake
15N.13W.18.442	[3]Mac #2	b	Jmb	1968; 1968-1970 - United Nuclear-Homestake
15N.14W.12.134	Mariano Lake (Section 12)	c	Jmb	1977-1982 - Gulf
17N.16W.35.200	N.E. Church Rock (2 shafts)	d	Jmw	1972-1982 - United Nuclear
17N.16W.35.200	N.E. Church Rock #1	d	Jmw	1976-present - Kerr-McGee
17N.16W.36.100	N.E. Church Rock #1-E	c	Jmw	1979-present - Kerr-McGee
17N.16W.27.200	N.E. Church Rock #2	c	Jmw	1978-1982 - Kerr-McGee
13N.9W.30.143	Piedra Trieste (Section 30)	a	Jt	1979-1981 - Todilto Exp. & Dev.
13N.9W.19.420	[3]Poison Canyon	c	Jmp	1952-1962; 1976-1978 - Reserve
15N.13W.21.142	Ruby #1 } mined through	c	Jmb	1976-1979 - Western Nuclear
15N.13W.27.120	Ruby #2 } same decline			1980-1982 - Western Nuclear
15N.13W.25.224	Ruby #3	c	Jmb	1980-1982 - Western Nuclear
14N.9W.34.424	[3]Sandstone	d	Jmw	1959-1963; 1963-1970, 1974-1980-United Nuclear
13N.9W.1.200	[3,4]Section 1 (13N-9W) mined through Cliffside	d	Jmw	1970 - National Lead; 1967, 1969-1982-Kerr-McGee
14N.10W.10.244	[3]Section 10 (14N.10W)	c	Jmw	1957-1962, 1964; 1980-Cobb
14N.10W.12.411	[3]Section 12 (14N-10W)	c	Jmw	1961-1963; 1978-1982 - Cobb; 1980-United Nuclear
14N.10W.13.413	Section 13 (14N.10W)	c	Jmw	1977-1981 - United Nuclear-Homestake; 1981-Homestake
14N.10W.15.441	[3]Section 15 (14N.10W)	d	Jmw	1958-1964; 1969-1981 - United Nuclear-Homestake; 1981-Homestake
13N.9W.16.441	Section 16 (13N.9W) mined through Dog-Flea mines	b	Jmp	1973 - United Nuclear-Homestake
13N.9W.17.311	Section 17 (13N.9W) mined through Dog-Flea mines	b	Jmp	1972-1973 - United Nuclear-Homestake
14N.9W.17.323	[3]Section 17 (14N-9W)	d	Jmw	1960-1982 - Kerr-McGee
14N.9W.18.420	[3,4]Section 18 (14N-9W) mined through Section 17	d	Jmw	1962-1982 - Kerr-McGee
14N.9W.19.411	Section 19 (14N.9W)	d	Jmw	1978-present - Kerr-McGee

1: 13N.10W.19.110
2: Haystack-Section 19 Open-pit Complex (Section 24)
3: NW1/4 19 T13N R10W, NE1/4 NE1/4 24 T13N R11W 35°20'45"N 107°55'55"W
4: Bluewater 7-1/2 Elevation 7,100 ft
5: Ambrosia Lake subdistrict-Grants uranium district
6: U, V, limestone
7: large open pit complex - deepest 60-ft
8: 137,310 tons ore yielding 562,267 lbs U_3O_8 (0.20%); 165,494 lbs V_2O_5 until 1970. In 1979 produced 300 tpd
10: Jurassic Todilto Limestone
11: mineralization in upper limestone, associated with intraformational folds, largest orebody was 1,150-ft long and 130-520 ft wide
13: Limestone
14: produced intermittently 1952-1981, last producer Todilto Exp. and Dev. Co.; mine map by Gabelman (1956b, p. 393)
15: FN 5/21/82; Green and others (1980c, #200, 201, 301, 304, 331); Perkins (1979); Siemers and Austin (1979); Holmquist (1970, p. 106); Hilpert (1969, p. 36, #16); Kittle and others (1967); McLaughlin (1963, p. 146); U.S. Atomic Energy Commission (1959a, p. 53); Fincher and Konigsmark (1957); Gabelman (1956b); Chew (1956); PRR CEB-9 (1950); USAEC files (1965)

1: 13N.9W.14.414
2: Hogan Mine
3: SE1/4 14 T13N R9W 35°21'10"N 107°45'30"W
4: Dos Lomas 7-1/2 Elevation 6,920 ft
5: Ambrosia Lake subdistrict-Grants uranaium district
6: U, Mo
7: 340-ft vertical shaft
8: 129,551 tons ore yielding 678,510 lbs U_3O_8 (0.26%)
10: Jurassic Morrison Formation-Brushy Basin Member-Poison Canyon sandstone bed
11: redistuted ore bodies in 3 horizons along flank of anticlinal fold parallel to San Mateo fault, related to a facies change
12: coffinite, jordisite
13: Sandstone-redistributed
14: mined 1959-1962
15: Anderson, O.J. (1980); Green and others (1980c, #219); Perkins (1979, p. 70); Santos (1970); Holmquist (1970, p. 42); Hilpert (1969, p. 33, #39); Rapaport (1963, p. 131); Mining World (1959, p. 46-48); USAEC files (1962)

1: 13N.8W.18.244
2: Section 18 (Palo Verde Group)
3: NE1/4 18 T13N R8W 35°21'25"N 107°43'5"W
4: San Mateo 7-1/2
5: Ambrosia Lake subdistrict-Grants uranium district
6: U
7: drill holes - mined through Johnny M (1,100-1,400 ft)
8: no production
10: Jurassic Morrison Formation
11: 6-10 ft thick ore deposits
13: Sandstone
15: USAEC files (1958)

1: 13N.10W.18.233
2: Section 18 NEQ
3: NE1/4 18 T13N R10W 35°21'25"N 107°55'55"W
4: Bluewater 7-1/2
5: Ambrosia Lake subdistrict-Grants uranium district
6: U
7: drill holes
8: no production
10: Jurassic Todilto Limestone
13: Limestone
15: Green and others (1980c, #197); Hilpert (1969, p. 36)

1: 13N.10W.18.341
2: Section 18 (Williams and Thompson, Brown Vandever)
3: SW1/4 18 T13N R10W 35°21'2"N 107°56'25"W
4: Bluewater 7-1/2 Elevation 7,140 ft
5: Ambrosia Lake subdistrict-Grants uranium district
6: U, V
7: 200-ft inclined shaft, open pits, 2nd shaft
8: 25,796 tons ore yielding 98,175 lbs U_3O_8 (0.19%); 75,342 lbs V_2O_5
10: Jurassic Todilto Limestone
11: 4-5 ft thick orebodies
12: pitchblende, barite
13: Limestone
14: mined 1952-1953, 1955-1959, 1963-1964, 1966
15: Green and others (1980c, #198, 327); Holmquist (1970, p. 105); Hilpert (1969, #32, p. 36); McLaughlin (1963); U.S. Atomic Energy Commission (1959a, p. 53); Anderson, E.C. (1955); PRR CEB-10 (1950); USAEC files (1971); USBM files (1955)

1: 13N.9W.31.214
2: Unknown quarry (Santa Fe Railroad, Henri Dole)
3: C NE1/4 31 T13N R9W 35°19'00"N 107°49'30"W
4: Dos Lomas 7-1/2 Elevation 6,820 ft
5: Ambrosia Lake subdistrict-Grants uranium district
6: U, limestone
7: open pit
8: production, if any, included with Section 31 Strip
9: bkgd 20-30 cps, high on outcrop 150 cps
10: Jurassic Todilto Limestone, Entrada Sandstone
11: spotty and discontinuous ore along bedding planes
12: carnotite
13: Limestone
14: mined out
15: FN 4/6/82; Green and others (1980c, #298); Hilpert (1969, p. 35); USAEC files (1960)

1: 13N.10W.19.120
2: Unknown (Hutton-Titchen Group)
3: 18, 19 T13N R10W 35°21'00"N 107°55'40"W
4: Bluewater 7-1/2
5: Ambrosia Lake subdistrict-Grants uranium district
6: U
7: drill holes
8: no production
10: Jurassic Todilto Limestone
13: Limestone
15: Green and others (1980c, #307, 331)

1: 13N.10W.22.240
2: Unknown (G. Hanash, Indian Allotment)
3: 22 T13N R10W 35°20'00"N 107°53'00"W
4: Bluewater 7-1/2
5: Ambrosia Lake subdistrict-Grants uranium district
6: U
7: no workings
8: no production
10: Jurassic Todilto Limestone
12: tyuyamunite
13: Limestone
15: Green and others (1980c, #311); USAEC files (1960)

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 7

P. ANTONIO MARCH'92

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
PUBLIC HEALTH ADVISORY

NAVAJO-BROWN VANDEVER
AND
NAVAJO-DESIDERIO URANIUM MINING AREAS
NAVAJO NATION
BLUEWATER, NEW MEXICO

November 21, 1990

Statement of Purpose

This Public Health Advisory is issued to inform the Environmental Protection Agency (EPA), the Navajo Nation, the Indian Health Service (IHS), the Bureau of Indian Affairs (BIA), the State of New Mexico, and the public of a potential significant environmental hazard to human health rear Bluewater, New Mexico. After evaluating available information (1,2) and visiting the area, the Agency for Toxic Substances and Disease Registry (ATSDR) has determined that this Public Health Advisory is warranted for the Navajo-Brown Vandever (N-BV) and Navajo-Desiderio (N-D) Uranium Mining Areas. The presence of uranium-containing radioactive mine wastes, areas potentially contaminated with heavy metals, and many physical hazards form the basis of this Advisory. Because of these potential hazards to human health, the ATSDR is recommending that these sites be evaluated for inclusion on the National Priorities List.

At the request of the EPA, Region VI, and the Navajo Superfund Office (NSO), the ATSDR initiated preliminary investigations of the radiological, chemical, and physical hazards associated with the N-BV and N-D uranium mines. These sites are not currently on the National Priorities List, but the NSO and the EPA are currently developing Preliminary Site Assessments.

Two site visits by the ATSDR staff were made to the Navajo-Brown Vandever and Navajo-Desideri› Uranium Mining Areas. Field monitoring data were taken at the time of the visits. The ATSDR has concluded, based on the site visits, the data acquired during the visits, and the evaluation of other available information, that radioactive materials potentially hazardous to human health may be present at these sites. These hazardous materials include uranium-containing mine wastes with radiation levels potentially hazardous to human health, areas potentially contaminated with heavy metals at soil concentrations potentially hazardous to human health, and many physical hazards of public health concern. This finding has led to the issuance of this Public Health Advisory.

Background

The N-BV and N-D sites are in Bluewater, about 4 and 9 miles east of Prewitt, New Mexico, respectively (1,2). Both areas are in the Ambrosia Lake subdistrict of the Grants Uranium Mining District. Access to the areas is over improved dirt roads. These mining areas are in agricultural rural settings and adjacent to residential properties. Both mines are located on land owned by the Navajo Nation and held in trust by the Bureau of Indian Affairs, United States Department of Interior. The current owner of the N-BV mine is Mr. Brown Vandever, who lives at the site with his extended family. The owner of the N-D mine is Mrs. Jenny Desiderio, who inherited the mine from her deceased husband and lives on the site with her extended family.

The NSO estimates that at each site there are approximately 65 people, 30 of whom are children. Less than 3 miles from the sites is a preschool with a student enrollment of about 30 children. The NSO also estimates that about 500 persons are potentially impacted by environmental hazards at these sites.

A potable municipal-type water supply system for the area is derived from a well installed by the IHS. The NSO estimates depth of the well is about 1,100 feet. However, the NSO believes that not all residents are on this water system. The wells used by those residences not on the public supply are well systems operated by windmills.

The N-BV area encompasses about 155 acres (1), and the N-D mine covers about 130 acres (2). Within a mile of the N-BV mine is the Navajo-Nanabah Vandever (N-NV) mine site. These sites initially were open-pit mining operations. Besides the open-pit operations, the N-BV area operated as a subsurface mine. The site therefore includes horizontal mine shafts and ventilation shafts, some of which are almost vertical. During the site visits, the ATSDR observed that household wastes had been deposited into some of these shafts. It was apparent that local residents were still using these shafts for solid waste disposal.

Historically, the N-BV mine was operated periodically from 1952 to 1966 by various companies including Santa Fe Uranium, Federal Uranium Mesa Mining Company, and the Cibola Mining Company. During the operations of this mine, conventional mining techniques were used. The ore removed from the mine was believed to be sorted by hand and shipped to regional mills located near Ambrosia Lake or Shiprock, New Mexico, or the Durango, Colorado, areas. In its draft Preliminary Assessment of the site, the NSO documented that over 25,000 tons were removed from the mine. The ore processing produced about 49 tons of uranium oxide (U_3O_8) and over 37 tons of vanadium pentoxide (V_2O_5). Ores not meeting the screening criteria for uranium content were discarded at the mine site. These ores now line the roads leading to the Brown-Vandever residential and mine areas (1).

From 1952 to 1957, the N-D mine was operated by "Sante Fe" (exact name unknown, may not be the same company as previously mentioned) and the Hanosh Mines from Grants, New Mexico. The mining technique involved removing the soil overburden with heavy equipment followed by drilling and blasting the ores loose. The ores then were trucked to area mills for processing. Ores not meeting the minimum requirements for uranium content were disposed of at on-site locations. The NSO estimates that the 11,110 tons of ore removed by this operation contained over 83,000 pounds of U_3O_8 and over 17,500 pounds of V_2O_5 (2).

At both the N-BV and the N-D mines, the physical hazards are of particular concern to the ATSDR because of the number of children known to reside in the areas. The physical hazards observed by ATSDR include both open mine shafts and open pits. Because of the depth of the shafts and the unrestricted access, an inadvertent intruder either entering or falling into the shafts could be difficult to find and rescue.

Explanation of Terms

This document uses terms associated with radioactivity and dose resulting from radiation exposure. These terms are defined here.

curie -- A curie (abbreviated Ci) is the unit used to measure the amount of radioactivity. It is equal to the amount of radioactivity in 1 gram of radium (1 gram = 1/28 ounce or 0.0022046 lb). A picocurie (pCi) is one trillionth of a curie (1×10^{-12}). One trillionth is the same as 1 second in 320 centuries or 1 inch in 16 million miles. Exposure levels of the radioactive gas radon are commonly expressed as picocuries per liter of gas (pCi/L).

roentgen -- A roentgen (abbreviated R) is used to measure exposure to ionizing radiation, such as gamma rays or X-rays. Gamma radiation is energy given off by certain radioactive substances, such as uranium and radium. Basically, a roentgen defines the amount of energy given off by these radioactive substances into the air. An exposure of 1 R = 87.7 rads per 1 gram of air.

rad -- The abbreviation "rad" stands for radiation absorbed dose. It measures how much radiation is absorbed by a material after exposure to radiation. It is equal to 100 ergs of energy per gram of material (an erg measures energy).

rem -- The abbreviation "rem" stands for roentgen equivalent man. It is a function of the radiation absorbed dose (rad) and the type (or quality) of radiation. In terms of radiation quality, gamma rays are the least harmful internally to humans and alpha particles are the most harmful. The effect of 1 rem is approximately the same as that of 1 R of X-ray or gamma ray radiation. A millirem = 1/1-thousandth of a rem, the same as a dollar in $1,000. A microrem = 1/1-millionth of a rem, the same as 1 minute in 2 years or 1 inch in 16 miles. Throughout the United States, the average natural radiation exposure (called "background levels") is nearly 300 millirems per year. This includes exposure to radon.

Background radiation occurs from natural sources in the earth's crust. Several naturally occurring radioactive materials contribute to this source of radiation. These include, but are not limited to, uranium, thorium, rubidium, and a small percentage of potassium. Other sources contributing to the background include fallout from cosmic radiation, materials made radioactive as a result of interactions with the cosmic radiation, and nuclear weapons testing. A measurement of the background radiation was collected at Prewitt, New Mexico, approximately 3 miles from these sites by the ATSDR and the NSO. Using radiation detectors sensitive to gamma radiation, the background radiation at Prewitt was estimated to be 6 microroentgens per hour (uR/h). This is equivalent to an annual exposure of 53 millirem, not including radon.

Basis for Advisory

During the week of July 24-27, 1990, and November 1, 1990, personnel from ATSDR Headquarters and Regions VI and IX offices toured these sites. Accompanying the ATSDR personnel were representatives of the local Navajo chapter and the NSO. During the visits, radiation readings were collected by both the ATSDR and the NSO. Discussions also were held with officials and members of the Navajo Nation concerning life-styles, populations, health concerns, and land use in these areas.

A. Navajo-Brown Vandever (N-BV) Site

Along the roadbed leading to the Navajo-Brown Vandever site, the area was littered with rocks and ore tailings. Mine tailings from the nearby Nanabah Vandever mine were within 100 feet from the roadbed. These piles were partially overgrown with vegetation. Within the materials along the roadbed, the uranium ores (yellowish material) were clearly visible. Environmental radiation readings along the road, obtained with a calibrated Ludlum Model 19 gamma radiation detector equipped with an NaI(Tl) scintillator, ranged from approximately 50 microroentgens per hour (uR/h) to over 500 uR/h, whereas the naturally occurring background radiation reading was 6 uR/h. The background radiation measurements were obtained in Prewitt, New Mexico, approximately 3 miles from the sites. Radiation monitoring evidence also suggested that radioactive material had migrated off-site because of both wind-borne distribution and surface runoff during seasonal rains. Additional radiation monitoring indicated that some residential structures contained radioactive material in the foundations and that radioactive materials were also present within 20 feet of the residential areas.

At the main mine shaft located in the pit-mined area, ore tailings were randomly piled around the site and radiation readings were elevated above background. A horizontal shaft entering the mountain was observed; and during discussions with local residents, it was mentioned that the shaft branches into three sections. Entrance to this mine shaft is not restricted. Vertical ventilation shafts were also observed; one shaft was about 10 degrees from vertical. A small shack was constructed over this ventilation shaft, however, access to the shaft was not effectively restricted. Located near the residential areas were open adits (shafts) being used as solid waste disposal areas by the local residents. These adits may run at least 300 feet in length or depth. The residential areas are less than 200 feet from several adits, and access to these adits is also unrestricted.

Although air sampling data are lacking, because of the uranium content of these mines, the shafts provide an excellent path for the release of radon, a naturally occurring by-product of uranium decay. It is reasonable to infer that the release of radon from these mines could elevate ambient radon to levels potentially hazardous to human health at this site.

During mining operations, analysis of the ores indicated the presence of heavy metals. These included vanadium, arsenic, barium, chromium, magnesium, manganese, strontium, titanium, and zirconium. Leaching may have occurred from these ores; however, no analyses of environmental samples are available to verify the presence of these contaminants. Although recent sampling information is lacking, the potential exists for humans to be exposed to these contaminants through ingestion or inhalation.

B. Navajo-Desiderio (N-D) Site

The Navajo-Desiderio mine is a series of open-pit areas of approximately 30 to 50 feet in depth and of varying lengths. The radiation readings at this site were about 50 uR/h. No restricted access to the pits was observed during the site visit; children play and livestock graze freely in the area, and residential areas are within 100 yards of the pits.

Through a Navajo interpreter, the owner of the mine, Mrs. Jenny Desiderio, informed us that her grandson fell into one of the pits during a sledding accident. The child, who reportedly suffered brain damage, died a few years after the accident. According to Mrs. Desiderio, at least 18 livestock died after ingesting contaminated rainwater that reportedly collects in the pits. Whether the dead animals were examined by a veterinarian is not known. Although sampling data are lacking, the NSO officials believe the animals may have died after ingesting heavy metals which may have leached from the ores into the pit areas.

C. Discussion of Site-related Radiological Contaminants

Of the verified contaminants in these areas, those of concern are uranium and a member of its decay series, radon. Of the naturally occurring isotopes of uranium, uranium-238 (U-238) is the most abundant, present at concentrations greater than 99 percent. The primary mode of decay is via two alpha particles, each with a decay energy of approximately 4.2 million electron volts (MeV). The decay chain of which U-238 is the parent results in the production of both radium-226 and radon-222 and ultimately terminates with stable lead-206. During this decay series, beta particles and gamma rays are produced as well as additional alpha particles, all at different decay energies (3). Because uranium is ubiquitous in nature, the daily human dietary intake is approximately 1.9 micrograms (4). Therefore, the body normally contains an estimated 90 micrograms of uranium. This corresponds to a body burden of about 30 picocuries. Of this amount, about 66 percent is associated with the skeleton; the remainder is in the soft tissues. The biological half-life is 100 days for whole body and 15 days for the kidneys (4).

After ingestion, the fractional uptake of uranium into the blood is 0.05 for water-soluble inorganic forms and 0.002 for water-insoluble forms (5). The critical organs for ingestion are the skeleton and kidneys. The lung surfaces are the critical organ after inhalation, although there is some solubilization of deposited uranium followed by absorption or ingestion (4).

Because Rn-222 is an inert gas, most of the inhaled gas is exhaled, with only that which decayed potentially remaining within the lungs. These radioactive materials deposited within the lung expose the bronchial epithelium lining the respiratory system, resulting in an elevated risk of lung cancer (5,6). Exposure to radon and radon progeny has been directly correlated with the appearance of lung cancer in humans. The first epidemiological studies of radon exposure were conducted in 1879, in Europe. Since then, such studies have been conducted worldwide and many are still in progress. The studies involve uranium miners and show increasing risks of lung carcinomas as accumulated exposure to these products increased (6).

Rn-222 decays by emitting an alpha particle with an energy of approximately 5.5 MeV and gamma rays with an energy of 0.51 MeV. The half-life of Rn-222 is 3.8 days (3). The decay products are also radioactive, emitting mostly beta particles and gamma rays with an alpha particle released during one decay step. These radon progeny, with half-lives ranging from seconds to over 20 years, ultimately decay to a stable (nonradioactive) form of lead.

The effects of biological exposure to radon are difficult to evaluate. Radon is inert and therefore does not attach to surfaces. However, the decay progeny are charged particles and can electrostatically attach to surfaces. Most progeny immediately attach to aerosols. The ratio of attached progeny to unattached progeny is important in dose calculations for as the ratio increases, the radiation dose to lung surfaces increases. Other factors affecting the lung dose include the ratio of Rn-222 to its progeny, the breathing patterns, lung characteristics, sex, and age of the individual exposed. In a recent report from the National Research Council (NRC), the dose from the radon progeny was of greater risk than exposure to radon gas (6). Dose estimates have been published by the National Council on Radiation Protection and Measurements (NCRP) (5). The NCRP estimates that the risk of developing lung cancer following a lifetime exposure to Rn-222 is 2.1×10^{-3} per pCi/L exposure under environmental conditions. The NCRP also states that the dose to the bronchial regions of a typical working adult because of exposure to Rn-222 is 0.27 rad per year per pCi/L. For a 10-year old child (12 hours active, 12 hours resting), the dose estimate is 0.45 rad/year per pCi/L.

D. Estimates of Radiation Exposure to Local Residents

Because detailed environmental monitoring for heavy metals and radioactive materials has not been supplied to the ATSDR, it is difficult to determine the health risks due to internal uptake of these materials. However, the external exposure to ionizing radiation can be evaluated using the on-scene monitoring results obtained by the ATSDR and the NSO. It is possible that the radiation exposures at these sites poses an imminent radiation health hazard to local residents. For the sites discussed in this Health Advisoıy, the ATSDR is defining an imminent radiation health hazard as exposures that exceed the regulations for radiation exposure to minors (as described in 10 CFR 20.104) and exposure to the public in areas of unrestricted access (10 CFR 20.105).

The Brown-Vandever mine site is in a residential area. In estimating the annual exposure to external ionizing radiation because of the contaminants in the area, the ATSDR used the following assumptions for a maximally exposed individual (MEI). The MEI would live on the site for 100 percent of the time (24 hours) and 365 days per year. The average exposure, including background in the area, is estimated conservatively to be approximately 125 uR/h. Assuming these values and the 24-hour exposure, the external radiation at this site could result in an individual receiving an external annual exposure of nearly 1 R, about 5 percent of which is from natural background as measured in the vicinity of the site (6 uR/h for 8,760 hours).

The risks of exposure to radiation have been investigated for nearly 100 years and the values have been extensively peer reviewed and accepted by the scientific community. In terms of risk estimates, the NCRP, in 1987, used a risk value for excess cancer mortality of 1×10^{-4} per rem per year for whole body exposure (7). In 1990, the NRC released the Biological Effects of Ionizing Radiation Report V, (BEIR V) (8). This report places the risk of excess cancer mortality as a result of continuous lifetime exposure to 0.1 rem pe- year at 520 for males and 600 for females per 100,000 population (Table 4-2, BEIR V report). Using the estimated population of 500 persons for this area, this would calculate to approximately three excess cancer deaths to residents as a result of exposure to the radiation over an estimated lifetime of 70 years. The American Cancer Society estimates that the expected rate of cancer deaths is on the order of 15 to 25 deaths for a population of 500 individuals.

Furthermore, because of the inherent production of radon released from the uranium-containing ores, the internal radiation dose, especially to the bronchial epithelium of the lungs, could be even higher. In a 1988 report, the NRC stated that the estimated dose to these tissues far exceeds any dose to organs from external natural background radiation (6). As an organ system, the allowable exposure limits for the lungs can exceed the whole body exposure dose limits (7). However, since no specific radon measurements have been made in this area, estimates of potential internal lung exposure to radon cannot be evaluated at this time.

Conclusions

The Agency for Toxic Substances and Disease Registry concludes that the Navajo-Brown Vandever and the Navajo-Desiderio Uranium Mining Areas may pose a potential significant hazard to human health for residents of these areas based on these premises:

1. The predictions of the external exposure model using the estimated exposures to ionizing radiation exceed the recommendations of the National Council on Radiation Protection and Measurements by a factor of 10. These recommendations state that the public exposure limit to continuous or frequent ionizing radiation should not exceed 0.1 rem per year (7), whereas, the estimated exposure to residents in the vicinity of the Brown Vandever mine could be on the order of 1 R (equivalent to 1 rem).

2. Possible human consumption of livestock potentially contaminated with heavy metals following the ingestion of standing water may pose a hazard to human health.

3. The many open mine areas, mine shafts, and the unrestricted access to these areas create a safety hazard.

4. Since evidence suggests that radioactive contaminants are migrating off-site and that heavy metals may be associated with the radioactive material, local food and livestock crops could be contaminated. This could result in a significant internal exposure to both radioactive materials and heavy metals if these crops are ingested.

5. It is apparent that not all local residents are supplied with public water. Because of the runoff and surface contamination around these sites, the water quality of the individual wells may be suspect and hazardous to humans chronically exposed to radioactive materials and heavy metals.

RECOMMENDATIONS

The ATSDR proposes the following health actions to assist local residents:

1. The ATSDR, in coordination with the Navajo Tribal Council, the IHS, the BIA, the State of New Mexico, and other appropriate agencies, will conduct an environmental health education program to advise the public and medical community of the nature and possible consequences of exposure to ionizing radiation and heavy metal contaminants at the N-BV and N-D sites. Health education materials and assistance will be provided to local health care providers and other appropriate local public health officials.

2. The ATSDR will consider conducting health surveillance activities for populations at these sites.

3. The ATSDR will consider conducting a radiation or heavy metal exposure study of the local residents once additional health-related information on the local residents becomes available.

Because of the limited environmental sampling data available to both the ATSDR and the EPA, we recommend the following additional actions to protect the public health of area residents:

4. The responsible environmental regulatory agencies should within the calendar quarter, initiate data collection efforts to begin the characterization and determination of the extent of the radioactive contamination and possible presence of heavy metals. This sampling should include public water supplies and private wells in the area. Those wells exceeding standards should not be used for potable water and residents should be supplied with alternate potable water.

5. During this phase, personal radiation dosimeters and radon detection devices should be provided by the appropriate agencies to local residents to begin to estimate the external radiation exposure being received.

6. During these environmental studies and personal monitoring efforts, if the data being collected indicates that an imminent radiation health hazard exists to the area residents, then immediate steps, including consultation with the ATSDR, should be taken to mitigate that health hazard.

7. The mitigation or remediation would include, as appropriate, dissociation of local residents from the site until the direct public health hazard is removed. The remediation of the public health hazard should occur in the most expeditious manner consistent with Federal and State environmental protection, health, and radiation protection laws and regulations. Appropriate steps should be taken to protect public health during any removal actions (e.g., dust control, site access restrictions, and monitoring of radiation levels).

8. If these analyses indicate that the radiation exposures would result in a long term, chronic exposure, then applicable measures should be taken by the appropriate remedial regulatory agencies to remediate the public health hazard in the most expeditious manner and consistent with all applicable Federal, Tribal, and State guidelines and recommendations.

9. The appropriate agency should sample biota, food crops, and livestock to ascertain the potential for internal radiation exposure through consumption of contaminated food products and to identify addition potential sources of external exposure.

10. The appropriate responsible agency should take steps to prevent access to or otherwise make physically safe the various open mine areas, pits, and shafts.

11. Governmental agencies and any involved private sector organizations should work closely with Navajo representatives to ensure that cultural awareness and respect are observed and practiced.

For additional information, please contact the ATSDR at the following address:

Robert C. Williams, P.E.
Director, Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
1600 Clifton Road, NE, MS E-32
Atlanta, Georgia 30333
(404) 639-0610
FTS 236-0610

REFERENCES

1. Molloy P. Preliminary Assessment for the Navajo-Brown Vandever Uranium Mine. Window Rock, AZ: The Navajo Nation. May 20, 1990.

2. Edison S. Preliminary Assessment for the Navajo-Desiderio Group Uranium Mines. Window Rock, AZ: The Navajo Nation. July 30, 1990.

3. U.S. Department of Health, Education and Welfare. Radiological Health Handbook. Washington, DC; 1970.

4. Eisenbud M. Environmental Radioactivity from Natural, Industrial, and Military Sources, 3rd ed. New York: Academic Press, Inc., 1987:475.

5. NCRP. Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States. NCRP Report 78. Bethesda: National Council on Radiation Protection and Measurements, 1984.

6. National Research Council. Health Risks of Radon and Other Internally Deposited Alpha-emitters. BEIR IV. Washington, D.C.: National Academy Press, 1988.

7. NCRP. Recommendations on Limits for Exposure to Ionizing Radiation. NCRP Report 91. Bethesda: National Council on Radiation Protection and Measurements, 1987.

8. National Research Council. Health Effects of Exposure to Low Levels of Ionizing Radiation. BEIR V. Washington, D.C.: National Academy Press, 1990.

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 8

P. ANTONIO MARCH'92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

December 2, 1991

MEMORANDUM

SUBJECT: Final Report by Cerrillos Land Company, Clean-up Action on Section 19, T13N, R10W of McKinley County.

FROM: Robert Bornstein RB
Federal On-Scene-Coordinator

TO: Bill Nelson, ATSDR (for distribution among ATSDR)
Ray Churan, DOI (for distribution among DOI agencies)
Stan Edison, Navajo Superfund (for distribution)
Linda Wandres, ORC
Bob Ivey, DOE

Enclosed is a copy of the post-removal report by Cerrillos Land Company. The report was submitted to EPA pursuant to EPA Order 91-16. If you need a copy of the post removal contour map please request a copy from Mr. Paul Eby of Cerrillos Land Company at 505-880-5300. Their post removal survey indicates that the site's gamma radiation levels have been significantly reduced to below 71 uR/hr (50 uR/hr divided by their instrument conversion factor of .7). Overall, within the reclamated areas, the section is reading approximately 28 uR/hr.

If you have any questions regarding this report, please contact me at 415-744-2298.

Cerrillos Land Company

6200 Uptown Blvd. N.E., Suite 400
Albuquerque, New Mexico 87110
Box 27019
Albuquerque, New Mexico 87125
505/880-5300 Fax# 505/880-5435

November 27, 1991

United States Environmental
Protection Agency
Region 1X
75 Hawthorne Street
San Francisco, CA 94105

ATTENTION: Mr. Robert Bornstein
On-Scene Coordinator
Emergency Response Section (H-8-3)

RE: Post Response Report
EPA Order 91-16

Dear Mr. Bornstein:

I am submitting for your approval the Post Response Report detailing response action taken on EPA Order 91-16. Also attached are the Affidavit, Pre-Response Survey, Post-Response Survey and related field documentation.

I want to thank you again for the guidance and cooperation you have provided during this project.

Should you require additional information, please contact me at this office.

Sincerely,

Paul G. Eby
Director - Field Operations

PGE/ps

cc: Tim Leftwich, w/Attachments
Wayne Jarke, w/Attachments
Denny Cole, w/Attachments
Project File, w/Attachments

Attachments

Cerrillos Land Company

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Albuquerque, New Mexico 87125
505/880-5300 Fax# 505/880-5435

POST RESPONSE REPORT

EPA ORDER 91-16

Receipt of Order

On August 5, 1991, Cerrillos Land Company received EPA Order 91-16. This order designated Cerrillos as a potentially responsible party for elevated gamma radiation from uranium sub-ore grade mine waste and large shallow open pits located in the NW 1/4, Section 19, Township 13N, Range 10W of McKinley County, New Mexico, where Cerrillos retains ownership of the mineral rights. The basis of this order was for Cerrillos to reduce the potentially hazardous gamma emissions from the site to a level acceptable to all agencies concerned (165 uR/hr above background or to a total of 180 uR/hr) in order to remediate potential health risk to families living nearby.

Acceptance of Order

As provided for in the order, Cerrillos Land Company requested a conference with EPA representatives in order to determine the exact nature of the order, for legal clarification and for guidelines on how to proceed. This accomplished, Cerrillos accepted the order on August 28, 1991, and proceeded with compliance.

Submittal of Site Work Plan - Health and Safety Plan

On August 28, 1991, a final Site Work Plan and Site Health and Safety Plan, detailing actions necessary to comply with the order, were submitted for approval. Included with the Work Plan was the pre-response gamma survey map, statement of qualifications for the contractor selected and statement of qualifications for the on-site coordinator. Approval of these Plans was received on September 4, 1991.

Cerrillos Personnel

Cerrillos personnel assigned the responsibility to comply with the order, their titles, and areas of responsibility are as follows:

PAUL G. EBY - DIRECTOR, FIELD OPERATIONS
Project Manager responsible for contractor selection and all physical work done at the site. Responsible for compliance with the Work Plan and Health and Safety Plan.

TIM LEFTWICH - DIRECTOR, ENVIRONMENTAL QUALITY
Contact for regulatory agencies. Provided consultation for scope and direction of all phases of project. Direct oversight responsibility for environmental and health issues relative to project.

BILL HARRISON - PROJECT ON-SITE COORDINATOR
On-site responsibility for compliance with Work Plan and Health and Safety Plan. On-site responsibility for coordination of reading gamma emissions of materials being moved and carrying out instructions from Project Manager. Controlled access to site and scanned personnel leaving site.

TONY J. CANABA - FIELD OPERATIONS - GRADE CONTROL
Provided gamma readings to contractor.

MARK GRAY - FIELD TECHNICIAN - GRADE CONTROL
Provided gamma readings to contractor.

Contractor Personnel and Equipment

Taylor Services of Grants, New Mexico, was the contractor selected by Cerrillos for site stabilization work. They have provided excellent, responsive and cost effective work on a very complex project. Key personnel are listed below:

Larry Taylor - Owner - Superintendent
Tony Canaba - Foreman - Operator
Dale Rowe - Operator
Paul Rowe - Operator
Mike McGinn - Operator
Rudy Purilla - Operator
Richard Grey - Operator
Raul Zapata - Driver
Multiple - Laborers

The primary equipment provided by Taylor Services for this project was either new or substantially equivalent to new. All equipment listed below was not run continuously, but on an as-needed basis.

3 - D-8 size Bulldozers
1 - D-6 size Bulldozer
1 - Front-End Loader (6 yd.)
1 - Road Grader
1 - End-Dump Truck
3 - Belly-Dump Trucks (Sub-contract)
1 - Office Trailer - Lunchroom

Contractor compliance with the Health and Safety Plan was excellent. Primary equipment had pressurized cabs and all equipment had back-up horns. Personnel wore hard hats, safety shoes or boots, safety glasses, radiation badges, and respirators when required. All Taylor and Cerrillos personnel were scanned for radiation before leaving the site.

Site Stabilization

Upon acceptance of EPA Order 91-16, Cerrillos was determined to reduce gamma radiation at the site to the lowest practical level below the required 180 uR/hr while using on-site fill and cover material. The initial gamma survey that was included with the Work Plan outlined an area of approximately 80 acres that would require either cut, fill, level, cover, transport, or some combination of these operations.

Earth moving operations began on September 4, 1991, on schedule. Initial operations began slowly with the use of one large bulldozer and one large front-end loader to allow Cerrillos' Project Manager and contractor to formulate a detailed equipment schedule and plan of operations. It was determined that each of the dozens of waste piles presented its own individual problems and that no real pattern existed. As the area had been mined by several companies, each waste pile must have been moved more than once and some, several times.

The resulting plan was to first level the pit floors to allow equipment access and to then fill the pits with the highest reading material on-site. Waste piles would be stripped, segmented and pushed in order to separate the "hotter" material from the lower reading material that would be used for cover or top dressing. Depending upon the proximity to a pit, this "hotter" material would be pushed, loaded and hauled, or leveled in place. All areas of higher readings would then be contoured and covered with lower reading or neutral material that would be transported by truck, if necessary. Grade Control Technicians on the ground would coordinate all machine operations.

During the second and third weeks of September, several more pieces of machinery were added and the project schedule accelerated to the maximum manageable level. Work proceeded, as planned, with only minor deviations. Some material had to be moved or covered two or more times to achieve acceptable readings. Mass effect in a larger area such as this proved difficult. Also, every effort was made to save as many Juniper and Piñon trees as possible. By mid-November, all areas were covered, contoured and made ready for the post-response survey and subsequent seeding.

Post Response Survey

The post-response radiometric survey over the property was performed by first laying out a 250′ x 250′ control grid over the area of disturbance. This was done with the use of a Brunton compass, tripod and a 300′ tape. At that point, each 250′ grid was internally divided into a 50′ grid, again utilizing the 300′ tape and setting pin flags at all points. Four Ludlum model 19 instruments, each calibrated against its own check source, were then used for the survey. This was performed using a measuring line and four men, each with an instrument held at a height of one meter above the ground and walking on 12 1/2′ centers on east-west lines to cover the entire property. At 50′ intervals, the highest reading from each instrument for that line was recorded on a chart. This then provided five line readings for 50′ grid, the highest of which was then recorded on the grid map provided as the final post-response survey.

The 500′ x 500′ grid sections on this map are numbered to correspond with the pre-response survey map submitted previously. Copies of each are submitted with this report. For your further edification, we are submitting the 500′ x 500′ grid charts showing line readings for each of the 50′ x 50′ grids.

All readings are below 50 uR/hr, uncorrected, which was Cerrillos' target level for the project.

Seeding Operations

Following the post response survey, seeding operations were delayed due to rain and snow. After the weather cleared and the ground dried sufficiently, seeding began on November 24th. Target date for completion is December 3rd.

Seed selection for the site included two warm season grasses, two cool season grasses and one forb. All are native to the area, are palatable to livestock, and demonstrate vigorous growth potential. Seed was blended for planting as follows:

Species	Variety	Rate PLS/ACRE
Blue Gramma	Hachita	2
Sideoats Gramma	El Reno	4
Indian Ricegrass	Paloma	3
Western Wheatgrass	Arriba	4
Fourwing Saltbrush	N.M. Origin	2
	TOTAL	15

Signs and Posting

Ten signs identical to EPA postings were acquired from Sign Art of New Mexico. All hazard warnings are in English, Navajo and Spanish. Posts were acquired from Unistrut and were 1 3/4" x 1 3/4" x 8'. Each sign was fitted with two posts and bolted with six carriage bolts each. Posts were set in cement two feet in the ground and were posted throughout the site opposite all access points.

Project Cost

Approximate expenditures on the project for all direct charged costs are as follows:

Title Work	$ 5,188
Ground Survey	7,142
Aerial Survey & Mapping	3,690
Instruments	5,515
On-Site Coordinator & Technician	17,670
Dirt Contractor	175,305
Seed	5,822
Miscellaneous	2,383
DIRECT PROJECT COST	$222,715

Conclusion of Report

Affidavit attached.

Affidavit

I, Paul G. Eby, being duly sworn and having direct knowledge of the following matters, do certify under penalty of law that based on my personal knowledge and appropriate inquiries of all other persons involved in the preparation of the report to which this affidavit is appended, the information submitted is true, accurate, and complete to the best of my knowledge and belief.

Dated Nov. 26, 1991

Paul G. Eby

STATE OF NEW MEXICO)
) ss.
COUNTY OF BERNALILLO)

The foregoing instrument was acknowledged before me this 26th day of November, 1991, by Paul G. Eby, the Director - Field Operations of Cerrillos Land Company, a Delaware corporation, on behalf of said corporation.

Notary Public

My commission expires:
September 20, 1994

HAYSTACK MOUNTAIN PROJECT

Grid No. 1 **Date** ______

		18 14 16 16	18 24 22 18	22 12 26 26	24 [illegible] 28 34	20 20 20 16	16 15 28 22	14 14 22 18	12 16 32 16
		16 14 15 16	28 26 22 22	30 32 30 26	24 24 24 28	18 20 26 20	16 20 20 36	20 22 20 20	20 22 12 22
		34 19 16 22	22 12 12 18	22 22 20 20	30 26 22 26	22 22 42 22	44 32 40 18	20 28 24 20	20 22 [illegible] 26
		34 30 42 22	22 46 44 32	24 26 28 24	30 20 22 18	22 16 16 16	18 18 24 22	28 26 28 24	20 20 20 18
		22 20 22 26	22 [illegible] [illegible] [illegible]	38 32 26 32	22 28 26 26	18 12 18 16	12 [illegible] 12 20	22 20 24 22	[illegible] [illegible] [illegible] 26

HAYSTACK MOUNTAIN PROJECT

Grid No. 2 **Date** ______

12	15	12	12	12	12	12	12		
20	20	16	14	12	12	12	14		
22	22	16	14	14	12	16	14		
20	22	18	18	14	12	10	14		
20	20	20	16	18	12	16	14	12	12
18	22	18	22	14	12	12	16	14	[illegible]
24	22	16	22	16	15	14	15	[illegible]	12
22	24	20	18	16	12	10	14	12	12
28	24	18	16	14	12	12	14	14	14
32	28	16	18	16	16	18	12	16	12
x22	28	20	20	16	15	14	12	14	16
26	24	20	24	16	16	14	14	12	12
20	20	28	28	22	18	12	12	14	14
22	24	32	32	24	18	19	16	12	14
20	22	21	30	34	22	21	20	15	14
14	20	26	28	36	22	20	14	16	14
18	18	22	26	24	20	18	18	18	14
16	22	28	22	20	22	12	12	26	14
30	26	20	21	20	18	20	20	20	12
24	18	26	24	24	20	18	16	22	12

HAYSTACK MOUNTAIN PROJECT

Grid No. 3 **Date** ______

14 12 16 12	14 16 16 14								

HAYSTACK MOUNTAIN PROJECT

Grid No. 4 Date

HAYSTACK MOUNTAIN PROJECT

Grid No. 5 **Date** ______

HAYSTACK MOUNTAIN PROJECT

Grid No. 6

Date

HAYSTACK MOUNTAIN PROJECT

Grid No. 7 **Date** ____________

28 / 12 / 8 / 28	17 / 20 / 20 / 17	28 / 22 / 22 / 22	18 / 22 / 24 / 28	22 / 22 / 22 / 24	18 / 18 / 22 / 22	12 / 22 / 20 / 22	12 / 12 / 22 / 22	12 / 22 / 18 / 12	12 / 22 / 22 / 22
26 / 27 / 17 / 18	[illegible] / [illegible] / [illegible] / 22	20 / [illegible] / [illegible] / 22	[illegible] / [illegible] / [illegible] / 22	23 / 22 / 26 / 22	22 / 22 / [illegible] / [illegible]	22 / 22 / 22 / 22	22 / 22 / [illegible] / [illegible]	[illegible] / [illegible] / [illegible] / [illegible]	[illegible] / [illegible] / [illegible] / 22
17 / 22 / 20 / 20	22 / 17 / 20 / [illegible]	22 / 22 / 22 / 22	27 / 28 / 22 / 28	22 / 22 / 22 / 22	22 / 22 / [illegible] / 22	[illegible] / [illegible] / [illegible] / [illegible]	[illegible] / [illegible] / [illegible] / [illegible]		
24 / 23 / 28 / 26	26 / [illegible] / 23 / 22	26 / 22 / 22 / 20	20 / 20 / 36 / 32	36 / 28 / 34 / 20	18 / 20 / 20 / 18	22 / 22 / 17 / 20	12 / 12 / [illegible] / 12		
26 / 20 / 22 / 18	20 / 24 / 28 / 20	20 / 11 / 20 / 18	20 / 22 / 12 / 16	22 / 22 / 22 / 16	17 / 17 / 20 / 20				
20 / 17 / 18 / 18	24 / 26 / 11 / 18	20 / 19 / 18 / 22	20 / 12 / 16 / 20	22 / 22 / 26 / 14	24 / 22 / 20 / 18	22 / 20 / 18 / 16	20 / 22 / 22 / 11	24 / 22 / 20 / 20	
28 / 26 / 26 / 20	22 / 26 / 24 / 28	20 / 22 / 22 / 20	24 / 27 / 20 / 28	18 / 17 / 16 / 16	17 / 16 / 18 / 16	17 / 14 / 17 / 14	24 / 22 / 24 / 22		
24 / 22 / 28 / 24	26 / 30 / 32 / 18	26 / 28 / 20 / 20	28 / 20 / 22 / 24	22 / 28 / 22 / 24	20 / 24 / 28 / 26	24 / 20 / 28 / 28	26 / 20 / 20 / 20		
22 / 20 / 20 / 12	20 / 28 / 32 / 28	24 / 22 / 24 / 22	22 / 20 / 26 / 22	20 / 24 / 22 / 24	32 / 28 / 28 / 26	20 / 20 / 28 / 22	28 / 20 / 22 / 20	[illegible]	
24 / 20 / 28 / 25	34 / 30 / 24 / 20	30 / 22 / 28 / 32	26 / 24 / 22 / 24	22 / 22 / 24 / 22	28 / 28 / 26 / 26	22 / 20 / 36 / 28	32 / 20 / 22 / 22	27 / 22 / 17 / 20	28 / 17 / 17 / 14

HAYSTACK MOUNTAIN PROJECT

Grid No. 8 Date ____________

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30 38 28 26	20 30 30 22	22 24 27 20	12 22 22 18	28 30 26 16	22 [illegible] 17 18	20 22 20 17	[illegible] 28 26 30	[illegible] 20 26 20	[illegible] 26 26 22
28 28 24 24	34 26 26 24	20 24 22 22	22 22 20 16	22 14 22 18	24 20 14 18	30 22 22 20	22 [illegible] 20 26	26 28 [illegible] 24	28 24 22 16
20 17 20 18	24 26 20 24	22 28 20 18	20 20 17 16	22 22 22 24	24 26 28 26	38 20 [illegible] 26	28 [illegible] 22 [illegible]	[illegible] 20 19 18	22 28 28 32
22 20 17 18	20 22 17 14	20 12 [illegible] [illegible]	22 12 [illegible] [illegible]	[illegible] 28 24 20	28 22 28 30	22 22 [illegible] [illegible]	20 22 28 [illegible]	24 [illegible] 22 22	40 [illegible] [illegible] [illegible]
18 14 16 14	12 12 [illegible] 18	18 18 12 12	20 22 22 22	24 26 27 32	24 30 30 26	28 26 28 26	26 30 20 20	24 28 26 26	22 20 40 22
20 20 24 20	18 14 14 14	22 16 18 12	32 22 22 18	28 32 30 26	28 28 26 28	26 28 22 22	28 30 30 20	28 24 22 26	28 24 22 32
22 16 12 12	12 14 14 14	12 20 24 20	22 24 22 26	26 22 26 22	26 28 26 24	28 22 28 26	22 24 26 22	20 38 22 32	26 20 26 36

HAYSTACK MOUNTAIN PROJECT

Grid No. 9 Date ______

		12 20 [illegible] 26	20 24 26 20	26 40 27 24	26 [illegible] [illegible] 26	[illegible] 20 20 [illegible]	20 17 [illegible] [illegible]	[illegible] 20 [illegible] 20	[illegible] [illegible] [illegible] [illegible]
		[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]
		[illegible] 20 20 [illegible]	[illegible] [illegible] 20 [illegible]	[illegible] 12 12 25	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	12 [illegible] 20 20	20 20 [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]
		[illegible] [illegible] [illegible] 26	18 22 26 24	[illegible] [illegible] [illegible] 16	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 20	22 [illegible] [illegible] 20	[illegible] [illegible] [illegible] 16	[illegible] [illegible] [illegible] [illegible]
		22 22 22 20	22 20 22 12	26 [illegible] 22 24	22 26 24 20	[illegible] 20 [illegible] 12	22 20 22 20	24 20 22 20	26 22 20 18
		20 12 [illegible] 12	22 22 24 22	24 22 26 22	26 28 20 20	22 12 14 16	20 22 [illegible] 22	20 22 22 12	22 12 18 16
		12 [illegible] 20 [illegible]	22 [illegible] [illegible] [illegible]	22 [illegible] [illegible] [illegible]	18 12 20 12	12 20 22 16	12 [illegible] 22 20	16 20 [illegible] [illegible]	[illegible] 12 20 [illegible]
		[illegible] 20 22 12	[illegible] [illegible] 22 12	[illegible] 24 28 26	22 24 26 26	[illegible] 20 20 20	22 20 [illegible] 22	20 22 12 20	[illegible] [illegible] 12 12
		20 14 14 22	18 [illegible] 22 22	26 24 49 38	28 28 32 28	22 12 12 [illegible]	12 12 [illegible] 14	18 16 18 16	20 [illegible] 22 20
		42 30 [illegible] 42	32 45 [illegible] 32	22 20 30 36	24 22 40 32	[illegible] [illegible] [illegible] 22	16 12 [illegible] 12	[illegible] 12 12 14	24 22 12 [illegible]

HAYSTACK MOUNTAIN PROJECT

Grid No. 10   Date ________

		26	32	20	34	24	22	[illegible]	[illegible]
		[illegible]	32	22	20	32	20	[illegible]	[illegible]
		[illegible]	[illegible]	22	32	28	23	12	[illegible]
		20	26	20	28	28	18	[illegible]	[illegible]
		[illegible]	28	[illegible]	18	14	18	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	16	16	18	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	22	12	18	[illegible]	[illegible]
		[illegible]	28	26	18	16	22	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		20	22	[illegible]	[illegible]	22	[illegible]	[illegible]	[illegible]
		[illegible]	22	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		20	22	[illegible]	22	20	[illegible]	[illegible]	[illegible]
		26	[illegible]	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		20	22	20	22	22	20	[illegible]	[illegible]
		24	[illegible]	20	24	28	22	[illegible]	[illegible]
		26	22	16	[illegible]	[illegible]	18	12	[illegible]
		22	22	20	22	20	18	16	14
		28	26	18	24	18	[illegible]	[illegible]	12
		28	26	18	20	20	16	16	12
		28	34	20	18	22	14	16	12
		30	22	20	22	22	[illegible]	[illegible]	18
		20	24	20	24	20	22	16	12
		34	24	26	20	26	22	16	12
		22	20	32	30	26	20	[illegible]	12
		30	20	28	28	24	22	18	[illegible]
		20	24	26	24	30	28	[illegible]	12
		20	20	[illegible]	[illegible]	[illegible]	18	[illegible]	[illegible]
		22	20	[illegible]	24	20	[illegible]	12	[illegible]
		26	28	28	28	30	18	14	[illegible]
		20	20	34	26	26	18	16	[illegible]
		22	22	28	27	30	24	14	12
		20	22	32	28	30	26	14	10
		20	20	24	32	26	18	12	10
		18	24	26	32	22	26	10	11
		18	22	28	32	20	22	10	11
		11	22	24	20	22	18	10	12
		18	28	28	26	30	20	14	[illegible]
		24	20	22	24	22	18	14	[illegible]
		18	24	28	26	22	18	12	[illegible]
		16	22	32	22	18	16	12	10

HAYSTACK MOUNTAIN PROJECT

Grid No. 11 **Date** ____________

[illegible] 12 [illegible] 12	20 12 12 12	[illegible] [illegible] [illegible] 12	22 20 [illegible] 16	26 22 26 20	24 26 24 22	24 24 24 20	22 22 [illegible] [illegible]	[illegible] [illegible] 22 [illegible]	[illegible] [illegible] 22 [illegible]
[illegible] [illegible] [illegible] [illegible]	[illegible] 12 12 12	[illegible] [illegible] 20 12	[illegible] [illegible] [illegible] [illegible]	22 [illegible] [illegible] [illegible]	20 22 20 14	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]
16 10 [illegible] 10	12 [illegible] [illegible] 10	[illegible] [illegible] [illegible] 14	[illegible] 16 14 14	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 18	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 14	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 34
12 10 11 10	12 14 16 12	14 12 14 14	16 14 15 14	[illegible] [illegible] [illegible] 14	[illegible] 12 12 14	12 [illegible] 15 14	15 [illegible] [illegible] 16	[illegible] 20 12 16	[illegible] [illegible] [illegible] 20
12 12 11 12	12 10 15 17	12 12 14 12	12 14 14 14	14 12 12 12	14 16 14 16	16 16 16 16	16 14 16 20	14 14 16 16	18 16 14 16
14 16 10 11	12 10 11 10	14 11 11 9	14 12 12 14	14 12 14 12	18 18 16 14	13 12 14 16	16 16 20 16	15 [illegible] [illegible] [illegible]	18 14 14 [illegible]
14 10 12 10	12 12 12 10	[illegible] [illegible] 12 12	[illegible] 14 [illegible] [illegible]	12 [illegible] [illegible] [illegible]	14 14 [illegible] [illegible]	16 14 [illegible] 14	18 14 [illegible] [illegible]	18 18 16 20	18 14 14 [illegible]
14 10 10 12	14 10 9 10	[illegible] 12 11 12	20 18 [illegible] 20	18 [illegible] 22 12	20 26 20 20	18 20 19 14	20 22 [illegible] 16	22 [illegible] [illegible] 22	18 20 20 16
12 12 [illegible] 10	14 12 12 10	14 12 11 10	22 22 20 16	18 15 12 14	24 22 16 14	16 12 14 14	18 16 [illegible] [illegible]	28 22 22 22	24 18 20 20
18 12 10 10	12 12 12 12	18 12 12 16	16 18 14 16	18 20 12 14	20 20 18 16	20 18 14 14	20 20 18 16	24 26 20 20	22 20 22 22

HAYSTACK MOUNTAIN PROJECT

Grid No. 12 **Date** ____________

30 [illegible] [illegible] [illegible]	[illegible] [illegible] 30 [illegible]	[illegible] [illegible] [illegible] [illegible]	24 [illegible] 28 22	28 [illegible] [illegible] [illegible]	26 [illegible] [illegible] [illegible]	26 28 22 [illegible]	[illegible] 20 [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]
22 28 [illegible] [illegible]	[illegible] [illegible] [illegible] 28	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 28	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]
[illegible] 30 24 [illegible]	30 22 36 [illegible]	[illegible] [illegible] [illegible] 28	28 [illegible] [illegible] 22	[illegible] 20 28 24	22 28 [illegible] [illegible]	20 [illegible] 26 28	22 20 22 22	28 [illegible] 25 22	[illegible] [illegible] 22 [illegible]
26 [illegible] 22 18	28 26 34 24	[illegible] 28 [illegible] 36	20 [illegible] 28 24	24 26 24 22	20 20 26 [illegible]	26 28 28 20	28 [illegible] [illegible] 24	[illegible] [illegible] 26 20	[illegible] [illegible] [illegible] 16
22 [illegible] 16 16	34 28 30 28	34 [illegible] 24 22	28 20 22 22	26 40 46 30	24 20 [illegible] 18	22 18 22 20	24 [illegible] 18 [illegible]	22 16 14 14	18 16 20 16
26 24 16 18	30 22 24 18	[illegible] 28 24 30	28 28 26 [illegible]	28 [illegible] 24 20	38 32 32 32	26 20 22 32	24 20 22 20	22 24 28 [illegible]	[illegible] 40 30 20
16 [illegible] 16 14	24 22 20 26	28 26 [illegible] [illegible]	30 24 28 32	24 26 30 24	32 38 30 [illegible]	34 34 46 28	[illegible] [illegible] [illegible] 28	22 [illegible] 28 28	30 [illegible] [illegible] 26
18 18 22 20	34 38 18 35	32 30 32 34	28 28 26 24	32 [illegible] 30 32	40 40 38 26	32 34 24 30	36 30 37 34	38 40 30 24	30 34 34 30
20 22 28 20	22 [illegible] [illegible] 16	24 22 28 20	32 26 24 22	30 36 30 32	26 28 32 38	28 34 30 22	40 32 34 30	22 30 38 22	32 36 38 28
26 [illegible] 32 30	26 22 20 18	30 [illegible] 20 22	20 [illegible] 26 24	36 28 40 38	42 40 42 42	38 [illegible] 42 40	30 36 [illegible] 32	28 [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]

HAYSTACK MOUNTAIN PROJECT

Grid No. 13 **Date** ____________

15 20 15 18									
[illegible] [illegible] [illegible] [illegible]	22 [illegible] [illegible] [illegible]								
[illegible] [illegible] [illegible] [illegible]	24 20 22 22	22 20 22 30							
32 28 32 26	34 26 34 32	32 30 34 24	[illegible] 24 22 24	22 [illegible] 20 [illegible]	[illegible] 26 20 20	[illegible] [illegible] [illegible] 25			
22 15 16 18	22 18 22 20	38 34 42 36	40 40 46 40	32 34 28 40	38 26 24 [illegible]	32 28 26 40	22 22 22 26	20 18 [illegible] 22	24 22 22 26
30 20 28 22	22 12 [illegible] 20	28 20 18 16	24 32 32 34	38 30 30 30	24 26 27 26	40 34 32 34	28 30 [illegible] 38	32 28 [illegible] 24	[illegible] 36 28 26
26 22 24 24	32 30 32 24	30 26 26 22	24 20 24 26	28 24 26 24	28 26 30 28	34 [illegible] 32 22	38 28 32 32	32 26 [illegible] 34	38 [illegible] 32 [illegible]
28 30 34 34	22 26 28 30	28 24 30 30	24 24 24 24	28 24 26 36	30 26 26 28	30 34 44 32	30 28 34 32	32 30 22 32	36 32 36 34
38 36 42 32	40 45 40 34	32 30 46 36	34 28 34 36	30 30 28 30	32 26 32 30	34 30 32 36	42 40 40 34	36 28 34 26	34 24 26 34
30 22 27 26	36 24 22 24	38 40 44 32	30 28 30 26	32 30 28 22	30 20 26 24	40 32 28 26	40 26 24 24	22 20 22 20	34 [illegible] [illegible] 24

HAYSTACK MOUNTAIN PROJECT

Grid No. 14 **Date** ____________

28 28 22 24	[illegible] 26 22 28	24 20 24 28							
22 24 24 22	26 22 2[illegible] 2[illegible]	[illegible] [illegible] 22 22							
30 [illegible] 24 32	22 26 22 24	24 22 2[illegible] 20							
24 22 [illegible] 30	32 26 22 22	22 30 40 32							
24 22 34 40	22 32 44 32	40 [illegible] 32 46							

HAYSTACK MOUNTAIN PROJECT

Grid No. 15 **Date** ______

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[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]								
[illegible] [illegible] [illegible] [illegible]									
[illegible] [illegible] [illegible] [illegible]									
26 24 30 26									
34 22 26 22									
[illegible] [illegible] [illegible] [illegible]									
26 [illegible] [illegible] 26									
[illegible]									

HAYSTACK MOUNTAIN PROJECT

Grid No. 16 **Date**

26 20 26 22	30 22 22 [illegible]	34 20 20 [illegible]	30 22 22 22	28 22 24 22	22 20 26 22	[illegible] 22 42 36	28 [illegible] 32 34	30 20 20 22	20 [illegible] [illegible] [illegible]
28 [illegible] 22 22	20 22 [illegible] [illegible]	22 22 24 [illegible]	24 28 24 [illegible]	28 24 20 22	[illegible] [illegible] 22 32	22 [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] [illegible]	24 22 [illegible] [illegible]	22 22 28 [illegible]
[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 28	[illegible] [illegible] [illegible] 28	[illegible] [illegible] [illegible] [illegible]	40 28 [illegible] 20	[illegible] [illegible] [illegible] 22	30 40 22 30	[illegible] [illegible] [illegible] 22	22 22 22 20	[illegible] [illegible] [illegible] [illegible]
28 22 28 28	[illegible] [illegible] [illegible] [illegible]	[illegible] [illegible] [illegible] 28	32 30 40 42	28 28 28 34	24 22 24 22	[illegible] [illegible] 28 24	[illegible] [illegible] [illegible] 24	32 30 [illegible] 26	22 22 22 28
38 30 30 32	28 28 20 28	40 20 32 32	38 28 24 26	40 44 28 32	32 40 30 36	38 30 40 30	42 26 24 24	28 20 22 22	30 24 26 32
26 24 34 22	28 24 24 20	40 32 30 28	24 20 22 20	30 22 28 22	30 20 26 22	28 24 30 20	30 28 22 28	24 24 22 22	40 22 22 40
34 40 44 40	24 20 [illegible] 26	24 22 22 22	28 18 22 22	20 26 18 20	18 18 18 22	22 20 20 20	30 20 32 [illegible]	26 40 26 28	30 [illegible] 40 26
40 24 36 24	42 28 24 28	28 24 26 26	28 34 28 32	28 42 26 24	36 30 38 34	26 40 30 24	24 20 36 26	28 24 [illegible] 24	30 22 26 24
26 22 28 28	24 30 28 28	30 28 40 40	32 30 34 26	26 22 26 28	38 24 28 32	24 20 28 20	28 32 22 30	34 28 34 34	32 26 32 [illegible]
28 17 16 18	30 22 22 22	38 24 24 26	28 20 20 28	40 32 32 32	26 38 38 24	24 28 24 20	36 30 34 32	42 36 36 28	44 42 [illegible] 28

HAYSTACK MOUNTAIN PROJECT

Grid No. 17 **Date** ____________

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HAYSTACK MOUNTAIN PROJECT

Grid No. 18 **Date**

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HAYSTACK MOUNTAIN PROJECT

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HAYSTACK MOUNTAIN PROJECT

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HAYSTACK MOUNTAIN PROJECT

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HAYSTACK MOUNTAIN PROJECT

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HAYSTACK MOUNTAIN PROJECT

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HAYSTACK MOUNTAIN PROJECT

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NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 9

P. ANTONIO MARCH'92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

NAVAJO-BROWN VANDERVER AND NAVAJO-DESIDERIO URANIUM MINING AREAS NAVAJO NATIONS BLUEWATER, NEW MEXICO PRELIMINARY ASSESSMENT WORKPLAN

Prepared by Robert Bornstein
United States Environmental Protection Agency
Emergency Response Section
November 9, 1990

I. INTRODUCTION

On October 3, 1990, the Emergency Response Section (ERS) was notified by the Agency for Toxic Substances and Disease Registry (ATSDR) of the potential health hazards associated with the uranium mining tailing located at the Navajo-Brown Vanderver (N-BV) and Navajo-Desiderio (N-DO) Uranium Mining Areas. At this time, the ATSDR is drafting a Public Health Advisory for these areas based on the potential adverse environmental and health hazards associated with these mining sites.

II. BACKGROUND

The N-BV and N-D sites are located in Bluewater, New Mexico. The sites are located on land administered by the Navajo Nation and lie within the Ambrosia Lake subdistrict of the Grants Uranium Mining District. The N-BV mine encompasses approximately 155 acres, and the N-D mine covers about 130 acres. The Sites lie within a sparsely populated agricultural area. The Navajo Nation estimate that approximately 500 people may be affected by the environmental hazards associated with these sites.

The N-BV mine was operated periodically from 1952-1966 and was operated by several mining firms including Santa Fe Uranium, Federal Uranium Mesa Mining Company, and the Cibola Mining COmpany. The operations consisted of both surface and subsurface mining techniques. Several open shafts and large pits are visible at the site and access is not restricted. The mined ore was hand sorted and shipped to various milling operations located in Shiprock, New Mexico, or the Durango, Colorado, area. It is estimated by the Navajo Nation that approximately 25,000 tons were removed from the mine. The ore was processed into approximately 49 tons of uranium oxide (U_3O_8) and over 37 tons of vanadium pentoxide (V_2O_5). Mined ore which failed to contain sufficient quantities of uranium were discarded at the mine sites. These tailing piles remain exposed at the sites. Several tons of tailings are believed to have been used as base material for neighboring roads and concrete.

The N-D mine was believed to be operated from 1952-1957. The exact name of the operating company or companies is not known at this time. This mine primarily employed strip mining techniques. The Navajo Nation estimate that over 11,110 tons of uranium ore was extracted from this operation.

III. ASSOCIATED HAZARDS

The ATSDR initiated a preliminary investigation at the sites to determine if they pose physical, chemical and/or radiological hazards. In summary, the ATSDR determined that the open pits and shafts do pose a significant physical hazard to the neighboring populations. The open shafts and pits are not fenced or secured and neighboring children may accidentally fall or get lost within these pits or shafts.

The ATSDR noted that the heavy metals associated with the weathering mine tailings may pose a significant environmental and health hazard. Heavy metals such as chromium, arsenic, vanadium, and zirconium may be leaching from the tailing piles and may be adversely affecting the groundwater quality of the region. In addition, neighboring populations may be exposed to wind blown heavy metal particulates.

Finally, the tailing piles contain elevated concentrations of radioactive material associated with the decay and degradation of uranium. Radioactive particulates and radon gas are likely to be migrating from the tailings. ATSDR believes that the neighboring population may be exposed to unsafe levels of radiation.

IV. ATSDR RECOMMENDATIONS

ATSDR has recommended action to assess and assist the local residents. ATSDR has recommended that an educational program be implemented to inform the neighboring population of the potential health effects of the mines. In addition, ATSDR has recommended that a more complete and detailed assessment be performed to assess the health impacts associated with the tailings.

ATSDR recommended that additional data be collected to characterize the amount and extent of contamination associated with the tailings. This would include collecting and analyzing soil, air and surface and groundwater samples for heavy metals and radioactivity. To investigate the radiation exposure of the neighboring population, ATSDR recommended the implementation of a personal radiation dosimeter program. Personal radiation dosimeters would allow ATSDR to estimate the external radiation exposure levels of the community. In addition, a complete biota, food crop and livestock study should be undertaken to evaluate the internal radiation exposure levels of the neighboring communities.

To implement ATSDR's recommendations, several Federal agencies such as the Bureau of Indian Affairs, Indian Health Services, EPA Superfund Program, EPA Office of Air and Radiation, Department of Energy, State of New Mexico and others will need to be involved with this project.

V. EMERGENCY RESPONSE ROLE

The Environmental Protection Agency Region IX, Emergency Response Section (ERS) has been tasked to perform the geochemical and georadiological study of the sites to assess the environmental and physical hazards of the area. ERS, accompanied by its Technical Assistant Team contractor, Ecology and Environment, are prepared to collect and analyze tailing, soil, air, surface water, run-off sediment and groundwater samples. EPA's Office of Air and Radiation, Las Vegas, Nevada, will be supporting ERS with their expertise in conducting radiation surveys and overseeing personal radiation safety.

An initial gamma radiation survey will be conducted by Colleen Petullo, OAR, to determine the external radiation hazards associated with the site. An "Exclusion" zone will be delineated by Collen Petullo, OAR health physicist, to restrict non 40 hr trained personnel and unauthorized people from access to the study areas. In addition, areas with gamma radiation levels exceeding 2.5 millirem/hr will be classified as "Hot" zones and personnel will not be allowed to work in these zones without direct supervision and approval of the health physicist. All personnel will be monitored exiting the study area. Instruments and protective gear will be monitored for radiation. Every effort will be made to avoid the generation of radioactive waste. A formal decontamination protocol will be implemented.

Physical hazards such as open shafts and pits will be delineated and flagged. An inventory to estimate the volume of potentially contaminated material will be collected.

Both surface and boring samples will be collected within the tailing piles and surrounding areas. Storm channel deposits will be collected to determine if rain run-off is acting as a mode of contamination transport. In addition, neighboring water well samples and, if possible, surface water samples will be collected and analyzed. All samples will be analyzed for heavy metals, radioactive isotopes and radioactivity. The samples will be collected pursuant to an approved sampling and work plan being drafted by Ecology and Environment. An extensive photographic record will be made during the assessment.

Areas of elevated gamma radiation will be delineated and used as potential monitoring stations for calculating radon flux measurements. These measurements will determine the amount of radon being emitted into the atmosphere from the tailings. If warranted a complete radon gas monitoring program above and down-wind of the tailing piles will be developed and implemented. Several carbon absorption test kits will be employed to capture the radioactive gas. Testing will be pursuant to the radon flux method outlined in 40 CFR Part 61. A domestic radon monitoring program and a biota/livestock sampling program has been recommended by ATSDR and ERS will try to coordinate these activities will other Federal and Navajo agencies.

The assessment will be directed by the ERS On-Scene-Coordinator (OSC). The OSC will be consulting and working closely with the various other Federal and Tribal agencies participating in this investigation. The assessment is scheduled to begin on November 13, 1990. A meeting between ERS personnel and the Navajo Superfund program is scheduled on November 13, 1990 at 4:00 pm. The OSCs assigned to lead the assessment are Robert Bornstein (415-744-2298) and Robert Mandel (415-744-2290). The project Health Physist from OAR will be Colleen Petullo (702-798-2446). The TAT Project Leaders are Mary Sue Philips and Beverly Pester (415-777-2811).

Analytical samples will be sent to TMA/Eberline laboratory located in Albuquerque. Sample analysis will be determined by using a flow chart developed by OAR.

The results of the sampling program will be compared to both Federal and State Action levels governing radioactivity and heavy metals. The following radioactive standards will be employed:

- o Drinking Water: 40 CFR 141
  MCL for radium-226 and radium 228: 5 pCi/l
  MCL for gross alpha particule activity (including radium-226 but excluding radon and uranium): 15 pCi/l
  MCL for gross beta: 50 pCi/l
  MPC (10 CFR 20) 9E-4 uCi/ml (U^{234})
  8E-4 uCi/ml (U^{235})
  1E-3 uCi/ml (U^{238})
- o Soil: 40 CFR 192
  Radium-226 in top 15 cm: not > 5 pCi/g over background
  Radium-226 below 15 cm: not > 15 pCi/g over background

- o Ambient Air: 40 CFR 192
  Radon-222: Average over 1 year over disposal areas not to exceed 20 pCi/m^2/sec (Radon Flux)
  Annual average at residential areas not to exceed 0.5 pCi/m^2/sec (Radon Flux)
  Radon-222 in occupied buildings: not to exceed .03 WL over background

  MPC (10 CFR 20): 1E-10 uCi/ml (U^{234})
  1E-10 uCi/ml (U^{235})
  7E-11 uCi/ml (U^{238})

- o Gamma radiation survey standard: >= 100 millirem/year*

  * Proposed Standard by the Presidential Working Group on Radiation Safety (DOE,HHS,ATSDR)

MCL = Maximum Contaminant Level
MPC = Maximum Permissible Concentration

Based on the results of the assessment, ERS will determine if an immediate health risk exists. If the promulgated standards are exceeded and an immediate health risk is established, ERS will prepare an Action Memorandum pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). If it is determined that a long term health risk is associated with the sites, ERS will refer this data to the Superfund Remedial Program. An emergency response action may include but is not limited to the following activities:

- The physical removal or encapsulation of the tailing piles;
- The proper closure of the mine pits and shafts;
- The relocation of exposed population;
- The supply of alternate water to the community;
- The erecting of warning signs and a fence to restrict assess to the sites;
- The application of a soil sealant to restrict the migration of contaminants from the sites.

If the NCP criteria for Removal Actions are met, an Action Memorandum will be forwarded to EPA Headquarters, Emergency Response Division to request funding approval. Headquarters approval is required because Removal Actions on Reservations have been determined to have "national" significance.

PROJECT CONTACTS

Robert Bornstein	On-Scene-Coordinator	415-744-2298
Robert Mandel	On-Scene-Coordinator	415-744-2290
William J. Weis	Enforcement Officer	415-744-2297
Linda Wandres	ORC	415-744-1359
Mike Bandrowski	Reg. Radiation Office	415-556-5285
Greg Dempsey	Las Vegas, OAR	702-798-2476
Colleen Petullo	OAR,Health Physicist	702-798-2446
Barbara Gross	Industrial Hygienist	415-744-1607
Louise Lincoln	Navajo Superfund	602-871-6422
Gavrav Rajen	Navajo Superfund	602-871-6859
Bill Nelson	ATSDR	415-744-2194
Mary Sue Philips	TAT Project Leader	415-777-2811
Beverly Pester	TAT QA Leader	415-777-2811
Vickey Radvila	TAT Member	415-777-2811

TRIP SCHEDULE

DEPARTURE: November 13, 1990 --- America West Flight HP431/HP202
OAKLAND TO ALBUERQUE
Departs: 0700 hrs
Arrives: 1140 hrs via Pheonix

RETURN: November 16, 1990 -- America West Flight HP640/HP10
ALBUERQUE TO OAKLAND
Departs: 1705 hrs
Arrives: 2015 hrs via Pheonix

Hotel: El Rancho, Gallup, New Mexico -- 505-863-9311
Car: Heritz Car Rental - 4 wheel drive - #7611-079-A4A6

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 10

P. ANTONIO MARCH'92

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

January 29, 1991

Gaurav Rajen, Project Manager
Navajo Superfund Progam
Navajo Nation
43 Crest Road
St. Micheals, Arizona 86511

SUBJECT: **Bluewater Uranium Mine Preliminary Assessment Data**

Enclosed are the radionuclide, metal and gamma survey data collected by the Emergency Response Section (ERS) preliminary assessment, conducted on November 15-16, 1990, at the Brown-Vandever and Desiderio Uranium Mine Sites, located outside of Prewitt, Navajo Nation, New Mexico. This assessment was performed at the request of the Agency for Toxic Substances and Disease Registry (ATSDR) to identify if the Sites pose any immediate adverse environmental and health hazards.

Site Background

The Navajo-Brown Vandever (N-BV) and Navajo-Desiderio (N-D) mine sites are located within the Ambrosia Lake subdistrict of the Grants Uranium Mining District. The N-BV mine site encompasses approximately 155 acres, and the N-D covers 130 acres. The sites lie within a sparsely populated agricultural area.

Several families live on both mine sites. Approximately thirty people live on the N-BV site, including children, and approximately forty people live on the N-D site. The land is primarily utilized as grazing areas for the cattle, horses, sheep and goats.

Both mine sites consist of strip mine pits, tailing piles and open vent and mine shafts. There are presently no barriers prohibiting access to these mined areas.

ATSDR issued a Health Advisory for the sites on November 21, 1990. Since then, ERS has been consulting with Greg Demspey and Colleen Petullo, Office of Air and Radiation, Las Vegas and Bill Nelson, ATSDR and yourself.

Data

Figure 1 shows the locations of the mine sites. Figure 2 shows the Brown-Vandever Mine Site and Figure 3 shows the Desiderio Mine Site. Table 1 contains the gamma survey data. Table 2 lists the radionuclide data obtained from the water and soil samples. Figure 4 divides the Brown-Vandever Mine Site into four sections which were surveyed and sampled. Figures 5-8 show the sampling locations within each section of the Brown-Vandever Mine Site. Figure 9 shows the sampling locations from the Desiderio Mine Site. Appendix A contains the results of the Radon Flux experiment conducted at the Desiderio Mine Site. Appendix B contains the heavy metal sample results. Appendix C contains the laboratory data sheets.

Assistance

At this time, ERS has requested OAR, ERD and ATSDR assistance in interpreting the radionuclide assessment data for the purpose of determining if an imminent and substantial health risk exists at either of the sites. For instance, the data reveals that nearly all of the sampling points within the mined areas appear to exceed the promulgated standard for Radium-226, which should not exceed 5 pCi/g above background within the first fifteen centimeters of soil, as outlined in 40 CFR Section 192.12. We need help in determining if the sites pose an acute (need to do a removal action) or a chronic (remedial action more appropriate) health risk. One criterion that could be used to determine if a removal action is warranted is an increased carcinogenic health risk of 1 in 10,000 or more after a two year exposure. This criterion is based on the following:

A) A risk of 1 in 10,000 is the high end of the risk range established by EPA in the NCP which requires a response action;

B) It is estimated that it would take over two years for the remedial program to be able to address these sites since neither has yet to be placed on the NPL.

It is important to select a number or criteria that can be used on more than one site since there are many similar sites in Arizona and New Mexico. Our decision is likely to set a precedent for future potential removal actions at these type of uranium mine tailing sites. In addition, ATSDR must determine what steps they must undertake in response to their Health Advisory based on what we determine to do at these sites.

As we discussed, at this time, this data is for internal review and comments. Please, do not release the data to the public. In addition, I am concerned over the preschool water sample. It appears that there may be a potential lab/sampling error. We are presently reviewing the laboratory information. However, to be on the conservative side, I recommend that this well be immediately resampled.

I look forward to working with you in the near future. Please contact me if you have any questions or concerns at 415-744-2298.

Sincerely,

Robert Bornstein

Robert Bornstein
On-Scene-Coordinator

cc: enclosures

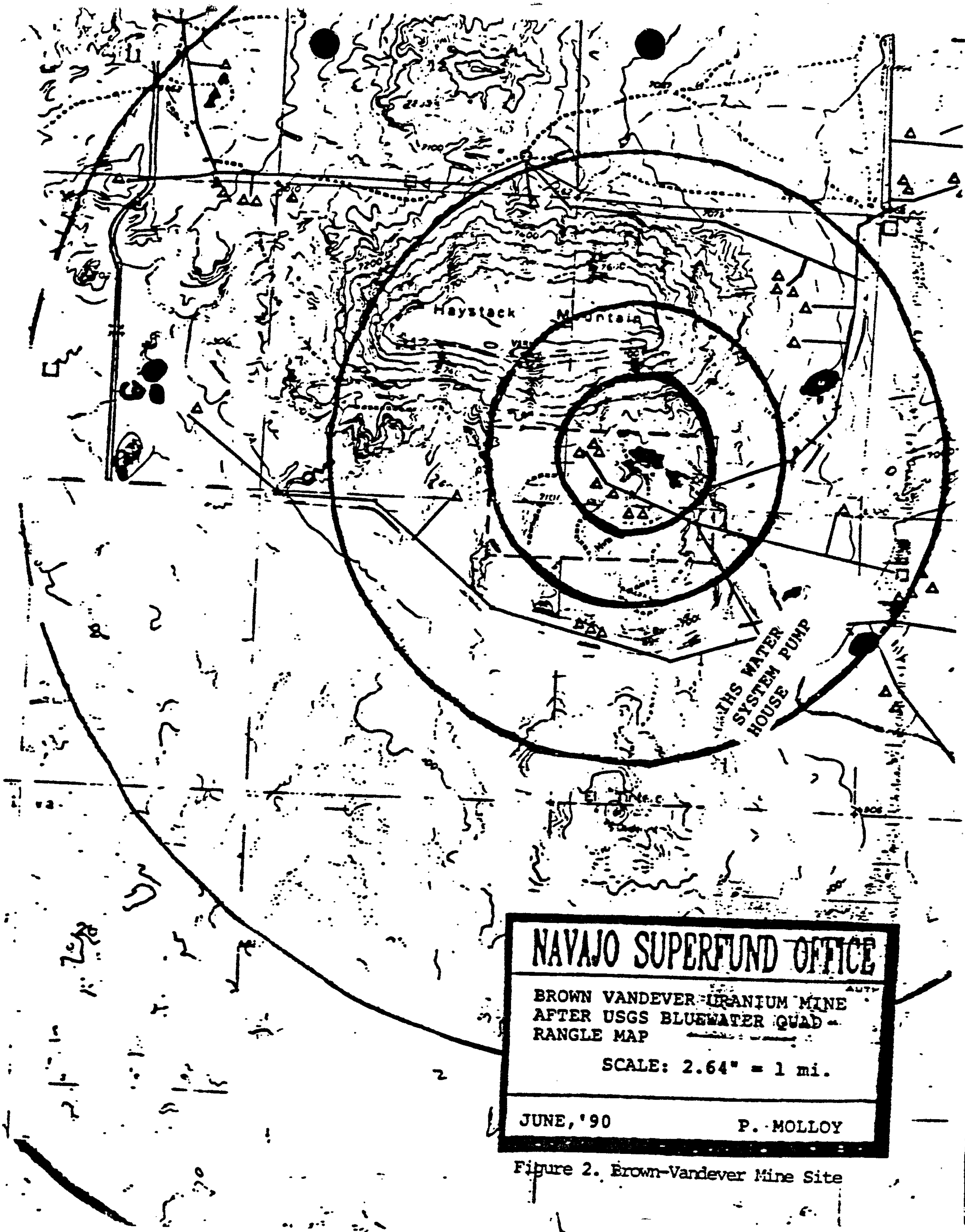

Figure 2. Brown-Vandever Mine Site

TABLE 1
GAMMA RADIATION SURVEY DATA
BROWN-VANDEVER MINE SITE, NAVAJO NATION

NOVEMBER 14-15, 1990

Operator - Collen Petullo   Recorder - Robert Bornstein

Instrument	ID#	Calibration date	Calibration Source
1 Ludlum 19	452663	11-08-90	Ra-226
2 Bicron	825481	10-15-90	Cs-137
3 Ludlum 12 Pancake	140830	11-08-90	Pu-239,Sr-90

Date 11/14/90 SECTION 1

Inst.	Time	Station	Ground	Waist	Comments
1 3	0900 0903	Background1	11 uR/hr 100 cpm	11 uR/hr 100 cpm	2.5 mi from site.
1 3	0908 0910	Background2	11 uR/hr 100 cpm	11 uR/hr 100 cpm	1.0 mi from site.
1	0930	Brown Home	13 uR/hr	14 uR/hr	stage area
1 2	1000 1001	Station 1	35 uR/hr 25 urem/hr	36 uR/hr 25 urem/hr	Center of dirt road
1 2	1003 1004	Station 2	130 uR/hr 70 urem/hr	135 uR/hr 60 urem/hr	near tree
1 2	1007 1008	Station 3	90 uR/hr 50 urem/hr	N/A N/A	contact on ground
1 2	1010 1011	Station 4	115 uR/hr* 75 urem/hr	100 uR/hr # 50 urem/hr	
1 2	1015 1017	Station 5	130 uR/hr 85 urem/hr	145 uR/hr 60 urem/hr	
1 2	1019 1020	Station 6	1200 uR/hr 800 urem/hr	800 uR/hr 400 urem/hr	In pit zone
1 2	1028 1033	Station 7	40 uR/hr 20 urem/hr	44 uR/hr 25 urem/hr	Away from pit area
1 2	1040 1044	Station 8	150 uR/hr 90 urem/hr	140 uR/hr 72 urem/hr	

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
1 2	1055 1057	Station 9	190 uR/hr 120 urem/hr	170 uR/hr 90 urem/hr	
1 2	1105 1108	Station 10	1250 uR/hr 750 urem/hr	800 uR/hr 350 urem/hr	open area
1 2	1113 1115	Station 11	400 uR/hr 300 urem/hr	200 uR/hr 150 urem/hr	
1 2	1118 1120	Station 12	600 uR/hr 500 urem/hr	500 uR/hr 300 urem/hr	
1 2	1122 1124	Station 13	500 uR/hr 250 urem/hr	500 uR/hr 400 urem/hr	
1 2	1127 1128	Station 14	600 uR/hr 300 urem/hr	700 uR/hr 300 urem/hr	
1 2	1134 1136	Station 15	230 uR/hr 150 urem/hr	280 uR/hr 150 urem/hr	
1 2	1140 1141	Station 16	700 uR/hr 300 urem/hr	600 uR/hr 250 urem/hr	
1 2	1150 1151	Station 17	80 uR/hr 40 urem/hr	120 uR/hr 35 urem/hr	
1 2	1155 1156	Station 18	90 uR/hr 50 urem/hr	65 uR/hr 35 urem/hr	
1 2	1300 1303	Station 19 SECTION 2	700 uR/hr 450 urem/hr	600 uR/hr 350 urem/hr	
1 2	1306 1309	Station 20	900 uR/hr 650 urem/hr	800 uR/hr 500 urem/hr	on pad
1 2	1314 1315	Station 21	300 uR/hr 250 urem/hr	230 uR/hr 150 urem/hr	attic
1 2	1320 1321	Station 22	230 uR/hr 130 urem/hr	210 uR/hr 100 urem/hr	edge of pile
1 2	1330 1334	Station 23	120 uR/hr 40 urem/hr	50 uR/hr 40 urem/hr	

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
1 2	1346 1348	Station 24	220 uR/hr 120 urem/hr	220 uR/hr 110 urem/hr	
1 2	1350 1352	Station 25	500 uR/hr 250 urem/hr	400 uR/hr 175 urem/hr	
1 2	1358 1400	Station 26	300 uR/hr 170 urem/hr	300 uR/hr 170 urem/hr	
1 2	1405 1408	Station 27	250 uR/hr 150 urem/hr	200 uR/hr 150 urem/hr	
1 2	1320 1322	Station 28 **SECTION 3**	10 uR/hr 5 urem/hr	10 uR/hr 5 urem/hr	11/15/90
1 2	1330 1330	Station 29	N/A	13 uR/hr 10 urem/hr	at window of vent
1 2	1333 1334	Station 30	80 uR/hr 50 urem/hr	80 uR/hr 50 urem/hr	lots of stones
1 3	1337 1338	Station 31	75 uR/hr 300 uR/hr	Lgm micro	on casing in hole
1 2	1345	Station 32	350 - 90 uR/hr on brick wall 250 - 50 urem/hr on brick wall		
1 2	1355 1400	Station 33 **SECTION 4**	15 uR/hr 10 urem/hr	15 uR/hr 10 urem/hr	
1 2	1405 1407	Station 34	125 uR/hr 90 urem/hr	90 uR/hr 50 urem/hr	
1 2	1410 1411	Station 35	25 uR/hr 10 urem/hr	25 uR/hr 10 urem/hr	
1 2	1415 1417	Station 36	225 uR/hr* 130 urem/hr	110 uR/hr* 70 urem/hr	on wall face
1 2	1420 1423	Station 37	600 uR/hr 300 urem/hr	600 uR/hr 300 urem/hr	dug area
1 2	1430 1433	Station 38	240 uR/hr 200 urem/hr	200 uR/hr 240 urem/hr	

Table 1. (Continued)

Inst.	Time	Station	Ground	Waist	Comments
1 2	1440 1443	Station 39	18 uR/hr 10 urem/hr	18 uR/hr 10 urem/hr	
1 2	1446 1448	Station 40	700 uR/hr 600 urem/hr	600 uR/hr 300 urem/hr	
1 2	1452 1453	Station 41	500 uR/hr* 350 urem/hr	400 uR/hr# 250 urem/hr	

* On contact with rock/tailing outcrop
\# 3 feet from contact

,/E411
Min
Site

DESIDERIO MINE SITE, NAVAJO NATION
NOVEMBER 15, 1990

Operator - Collen Petullo   Recorder - Vicky Radvilla

Instrument	ID#	Calibration date	Calibration Source
1 Ludlum 19	452663	11-08-90	Ra-226
2 Bicron	825481	10-15-90	Cs-137
3 Ludlum 12 Pancake	140830	11-08-90	Pu-239,Sr-90

Date 11/15/90 SECTION 1

Inst.	Time	Station	Ground	Waist	Comments
1 3	0825	Background1	11 uR/hr 100 cpm	11 uR/hr 100 cpm	2.5 mi from site
1 3	0830	Background2	11 uR/hr 100 cpm	11 uR/hr 100 cpm	1.0 mi from site
1 2	0855 0856	Station 1	12 uR/hr 7 urem/hr	12 uR/hr 6 urem/hr	at pond site
1 2	0857 0859	Station 2	18 uR/hr 8 urem/hr	18 uR/hr 8 urem/hr	at fense
1 2	0940 0941	Station 3	10 uR/hr 5 urem/hr	10 uR/hr 5 urem/hr	at base station
1 2	0955 0956	Station 4	20 uR/hr 7 urem/hr	24 uR/hr 7 urem/hr	large pit

APPENDIX A

SCIENTIFIC ANALYSIS, INC.

November 30, 1990

Ms. Mary Sue Philp
Ecology & Environment
160 Spear St.
San Francisco, CA 94105

Subject: Results of Radon Flux Testing
Navajo Uranium Mine Sites
New Mexico

Dear Ms. Philp:

Scientific Analysis, Inc, is pleased to provide you with the results of 50 radon flux measurements performed on November 15-16, 1990 on three Navajo uranium mine sites using the 4" charcoal canister device (SAACC). While the SAACC procedure is not an EPA approved method, side by side measurements using the SAACC and the EPA approved procedure (LAACC) demonstrate comparable results when respective arithmetic means are computed and compared with each other.

The arithmetic mean radon flux levels were 51.4, 67.0, and 47.7 pCi/m^2-s, respectively for stations 5, 6, and 7. For comparison purposes, the 40 CFR Part 61 standard for operating uranium mill tailings piles limits radon emissions to 20 pCi/m^2-s.

Individual flux results are presented in the attached Tables Tx where the prefix NU5 refers to Navajo Uranium Station 5, NU6 refers to Navajo Uranium Station 6, and NU7 refers to Navajo Uranium Station 7. Each table is divided into subparts (v) valid test results, (d) duplicate test results to demonstrate counting precision, and (b) "blank" results to check internal quality control. Based on counting results, measurements identified as NU5-20404, NU6-20420, and NU7-20433 are most likely blanks (i.e. unexposed SAACC).

Table QA outlines the quality assurance results. Sampling conditions such as ambient temperature and rainfall are unknown to SAI but are assumed to be within the limits prescribed in the SAACC procedure. In addition, a copy of the sample chain of custody form is included for your files.

If you have any questions regarding these results and this letter report, please do not hesitate to call me. All data and reports will be treated as confidential and will not be released without your written approval.

Sincerely,

SCIENTIFIC ANALYSIS, INC.

Thomas R. Horton

Thomas R. Horton
Radiation Consultant

TH/rlr

attach: Table (4)

6012 E. SHIRLEY LANE, MONTGOMERY, AL 36117 □ TEL: 205-271-0643 □ FAX: 205-271-0818

Table QA

Quality Assurance Results

Mine Stations	% Completeness	Counting % Precision	Blank (Blind) Identification
Overall	100	0.2	*

*All blanks (blinds) were presumably found and calculated to have an equivalent flux of zero.

SAI SCIENTIFIC ANALYSIS, INC.

U.S. EPA LISTED
RADON LABORATORY

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE IV. VALID TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
WU5-20384	11/15/90	11:38 am	11/16/90	10:17 am	11/20/90	09:14 am	0.1659	56136	616	52.9
WU5-20385	11/15/90	11:40 am	11/16/90	10:17 am	11/20/90	09:26 am	0.1659	65891	616	62.3
WU5-20386	11/15/90	11:32 am	11/16/90	10:21 am	11/20/90	09:46 am	0.1659	37381	616	34.9
WU5-20387	11/15/90	11:30 am	11/16/90	10:18 am	11/20/90	09:58 am	0.1659	38564	616	36.1
WU5-20388	11/15/90	11:34 am	11/16/90	10:19 am	11/20/90	10:09 am	0.1659	41146	616	38.7
WU5-20389	11/15/90	11:37 am	11/16/90	10:18 am	11/20/90	10:20 am	0.1659	50799	616	48.1
WU5-20390	11/15/90	11:42 am	11/16/90	10:15 am	11/20/90	10:31 am	0.1659	41825	616	39.8
WU5-20391	11/15/90	11:44 am	11/16/90	10:16 am	11/20/90	10:42 am	0.1659	37511	616	35.7
WU5-20392	11/15/90	11:31 am	11/16/90	10:18 am	11/20/90	10:53 am	0.1659	72031	616	68.5
WU5-20393	11/15/90	11:30 am	11/16/90	10:21 am	11/20/90	11:04 am	0.1659	73480	616	69.7
WU5-20394	11/15/90	11:27 am	11/16/90	10:20 am	11/20/90	11:18 am	0.1659	67716	616	64.3
WU5-20395	11/15/90	11:23 am	11/16/90	10:20 am	11/20/90	11:31 am	0.1659	41909	616	39.5
WU5-20396	11/15/90	11:45 am	11/16/90	10:21 am	11/20/90	11:50 am	0.1659	133063	616	129
WU5-20397	11/15/90	11:44 am	11/16/90	10:22 am	11/20/90	12:01 pm	0.1659	124722	616	121
WU5-20398	11/15/90	11:40 am	11/16/90	10:21 am	11/20/90	12:13 pm	0.1659	26268	616	24.9
WU5-20399	11/15/90	11:41 am	11/16/90	10:21 am	11/20/90	12:26 pm	0.1659	70727	616	68.3
WU5-20400	11/15/90	11:48 am	11/16/90	10:13 am	11/20/90	12:39 pm	0.1659	21932	616	21.0
WU5-20401	11/15/90	11:45 am	11/16/90	10:17 am	11/20/90	12:56 pm	0.1659	27380	616	26.3
WU5-20402	11/15/90	11:51 am	11/16/90	10:13 am	11/20/90	01:06 pm	0.1659	19879	616	19.1
WU5-20403	11/15/90	11:48 am	11/16/90	10:23 am	11/20/90	01:18 pm	0.1659	28771	616	27.7

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 20; Average flux = 51.4

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7d. DUPLICATE TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
WU5-20390	11/15/90	11:42 am	11/16/90	10:15 am	11/21/90	11:40 am	0.1647	34465	570	39.9
WU5-20399	11/15/90	11:41 am	11/16/90	10:21 am	11/21/90	11:51 am	0.1647	59115	570	68.6

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 2; Average flux = 54.3

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7b. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	---- On Stack -----		--- Off Stack ----		-- Count Begun ---		Counter Eff.	Gross Cnts	Background	Flux
NU5-20404	11/15/90	11:50 am	11/16/90	10:19 am	11/20/90	01:30 pm	0.1659	627	616	0.0

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 1; Average flux = 0.0

SCIENTIFIC ANALYSIS, INC.

U.S. EPA LISTED RADON LABORATORY

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE IV. VALID TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
MU6-20405	11/15/90	12:05 pm	11/16/90	10:23 am	11/20/90	01:41 pm	0.1659	18532	616	17.9
MU6-20406	11/15/90	12:03 pm	11/16/90	10:23 am	11/20/90	01:52 pm	0.1659	65963	616	65.2
MU6-20407	11/15/90	12:00 pm	11/16/90	10:23 am	11/20/90	02:03 pm	0.1659	88587	616	87.7
MU6-20408	11/15/90	12:01 pm	11/16/90	10:25 am	11/20/90	02:14 pm	0.1659	58818	616	58.1
MU6-20409	11/15/90	12:07 pm	11/16/90	10:27 am	11/20/90	02:25 pm	0.1659	45538	616	45.0
MU6-20410	11/15/90	12:06 pm	11/16/90	10:28 am	11/20/90	09:03 am	0.1638	43613	618	41.8
MU6-20411	11/15/90	12:02 pm	11/16/90	10:26 am	11/20/90	09:14 am	0.1638	84389	618	81.5
MU6-20412	11/15/90	12:04 pm	11/16/90	10:29 am	11/20/90	09:26 am	0.1638	62770	618	60.5
MU6-20413	11/15/90	11:59 am	11/16/90	10:30 am	11/20/90	09:46 am	0.1638	46518	618	44.6
MU6-20414	11/15/90	12:07 pm	11/16/90	10:31 am	11/20/90	09:58 am	0.1638	46848	618	45.2
MU6-20415	11/15/90	12:10 pm	11/16/90	10:28 am	11/20/90	10:09 am	0.1638	57169	618	55.6
MU6-20416	11/15/90	11:55 am	11/16/90	10:25 am	11/20/90	10:20 am	0.1638	57660	618	55.7
MU6-20417	11/15/90	11:58 am	11/16/90	10:25 am	11/20/90	10:31 am	0.1638	146693	618	143
MU6-20418	11/15/90	11:57 am	11/16/90	10:25 am	11/20/90	10:42 am	0.1638	124072	618	121
MU6-20419	11/15/90	11:53 am	11/16/90	10:25 am	11/20/90	10:53 am	0.1638	84129	618	81.8

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 15; Average flux = 67.0

SCIENTIFIC ANALYSIS, INC.

U.S. EPA LISTED
RADON LABORATORY

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE Td. DUPLICATE TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
FU6-20410	11/15/90	12:06 pm	11/16/90	10:28 am	11/21/90	11:40 am	0.1642	35937	634	41.9
FU6-20420	11/15/90	11:50 am	11/16/90	10:25 am	11/21/90	11:51 am	0.1642	625	634	0.0

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 2; Average flux = 20.9

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7b. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	—— On Stack ——		—— Off Stack ——		— Count Begun —		Counter Eff.	Gross Cnts	Background	Flux
WU6-20420	11/15/90	11:50 am	11/16/90	10:25 am	11/20/90	11:04 am	0.1638	640	618	0.0

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 1; Average flux = 0.0

SAI SCIENTIFIC ANALYSIS, INC.

U.S. EPA LISTED
RADON LABORATORY

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE IV. VALID TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
NU7-20421	11/15/90	12:14 pm	11/16/90	10:29 am	11/20/90	11:18 am	0.1638	40588	618	39.7
NU7-20422	11/15/90	12:16 pm	11/16/90	10:29 am	11/20/90	11:31 am	0.1638	67549	618	66.7
NU7-20423	11/15/90	12:18 pm	11/16/90	10:30 am	11/20/90	11:50 am	0.1638	53832	618	53.2
NU7-20424	11/15/90	12:22 pm	11/16/90	10:30 am	11/20/90	12:01 pm	0.1638	29053	618	28.6
NU7-20425	11/15/90	12:22 pm	11/16/90	10:30 am	11/20/90	12:13 pm	0.1638	37118	618	36.7
NU7-20426	11/15/90	12:19 pm	11/16/90	10:30 am	11/20/90	12:26 pm	0.1638	37697	618	37.3
NU7-20427	11/15/90	12:15 pm	11/16/90	10:30 am	11/20/90	12:39 pm	0.1638	42691	618	42.2
NU7-20428	11/15/90	12:18 pm	11/16/90	10:33 am	11/20/90	12:56 pm	0.1638	55381	618	55.1
NU7-20429	11/15/90	12:20 pm	11/16/90	10:34 am	11/20/90	01:06 pm	0.1638	39554	618	39.2
NU7-20430	11/15/90	12:12 pm	11/16/90	10:35 am	11/20/90	01:18 pm	0.1638	41457	618	41.0
NU7-20431	11/15/90	12:24 pm	11/16/90	10:34 am	11/20/90	01:30 pm	0.1638	46276	618	46.3
NU7-20432	11/15/90	12:26 pm	11/16/90	10:32 am	11/20/90	01:41 pm	0.1638	84987	618	85.9

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 12; Average flux = 47.7

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE 7d. DUPLICATE TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	On Stack		Off Stack		Count Begun		Counter Eff.	Gross Cnts	Background	Flux
NU7-20430	11/15/90	12:12 pm	11/16/90	10:35 am	11/21/90	12:02 pm	0.1642	35074	634	40.9

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 1; Average flux = 40.9

SUMMARY OF RADON FLUX COMPUTATIONS
TABLE Tb. BLANK TEST RESULTS FOR TOP OF STACK
Scientific Analysis, Inc.; Montgomery, Alabama 36117

11/27/90

Detector	---- On Stack -----		--- Off Stack ----		-- Count Begun ---		Counter Eff.	Gross Cnts	Background	Flux
M07-20433	11/15/90	12:15 pm	11/16/90	10:30 am	11/20/90	01:52 pm	0.1638	622	618	0.0

NOTE: All times are local stack times; Counting time is 10 minutes; Flux is given in pCi/Sec-Sq M
NOTE: Number of Flux Measurements = 1; Average flux = 0.0

SCIENTIFIC ANALYSIS, INC.

CHAIN OF CUSTODY RECORD

Radon Flux Testing

Job Name: Ecology & Environment - Navajo Uranium Mine Sites

Samplers (Name and Signature): Mary Sue Philp [signature]
Beverly Pester [signature]

Sample Locations/Sample ID Numbers (Collector Numbers):
#20384 to #20433

Sample Type: Exposed Charcoal in Plastic Container

Total Number of Samples: 50

Collection Date: 11/15/90 to 11/16/90

Relinquished By (Name and Signature): Mary Sue Philp
[signature]

Date/Time: 11/16/90

Received By (Name and Signature): Faith Ann McWhorter
Faith Ann McWhorter

Date/Time: 11-19-90 10:00 am

Relinquished By (Name and Signature):

Date/Time:

Received By (Name and Signature):

Date/Time:

SCIENTIFIC ANALYSIS, INC.

CHAIN OF CUSTODY RECORD

Radon Flux Testing

Job Name: Ecology & Environment – Navajo Uranium Mine Sites

Samplers (Name and Signature): Mary Sue Philp [signature]

Beverly Pester [signature]

Sample Locations/Sample ID Numbers (Collector Numbers):

#20384 to #20433

Sample Type: Exposed Charcoal in Plastic Container

Total Number of Samples: 50

Collection Date: 11/15/90 to 11/16/90

Relinquished By (Name and Signature): Mary Sue Philp

[signature]

Date/Time: 11/16/90

Received By (Name and Signature): Faith Ann McWhorter

Faith Ann McWhorter

Date/Time: 11-19-90 10:00 am

Relinquished By (Name and Signature):

Date/Time:

Received By (Name and Signature):

Date/Time:

APPENDIX B

Received: 12/06/90 | 01/21/91 15:49:23 | Work Order # A0-12-025

REPORT TO	TMA Eberline Corporation 5635 Jefferson Street NE Albuquerque, NM 87109
ATTEN	Rick Haaker
CLIENT	TMA EBERLINE — SAMPLES 28
COMPANY	TMA Eberline Corporation
FACILITY	Albuquerque, NM
WORK ID	E & E
TAKEN	By TMA Staff
TRANS	By UPS
TYPE	Solid & Liquids
P.O. #	Verbal - Dennis Wells
INVOICE	under separate cover

PREPARED BY	Thermo Analytical, Inc. 160 Taylor Street Monrovia, CA 91016
ATTEN	Ms. Carole Harris
PHONE	818-357-3247

CERTIFIED BY

CONTACT REM

This report is for the sole and exclusive use of the client to whom it is addressed and represents only those samples herein described. Samples not destroyed in testing are retained a maximum of 30 days unless otherwise requested.

SAMPLE IDENTIFICATION

01A
01A duplicate
01A Spike
01A Spike Duplicate
02A
03A
04A
05A
06A
07A
08A
09A
10A
11A
12A
13A
14A
15A
16A
17A
18A

TEST CODES and NAMES used on this workorder

3050IC	Strong Acid Dig.-Tot Met.
AS L	Arsenic - Liquids
AS S	Arsenic - Solids
AS SED	As/Se Digestion
METALS	METALS ANALYSIS
MPREPS	Metals Prep. - Solid
MPREPW	Metals Prep. - Liquid
PB LF	Lead by HGF
PB SF	Lead by HGF
SE L	Selenium - Liquids
SE S	Selenium - Solid
SR L	Strontium - Liquids
SR S	Strontium - Solids
ZR L	Zirconium - Liquids
ZR S	Zirconium - Solids

Received: 12/06/90 01/21/91 15:49:23

SAMPLE IDENTIFICATION

19 19A
20 20A
21 21A
22 W1
22 W1 Dulpicate
22 W1 Spike
22 W1 Spike Duplicate
23 W2
24 W3
25 W4
26 W5
27 W6
28 W7

Received: 12/06/90

TMA Inc. REPORT Work Order # A0-12-025

Results by Sample

SAMPLE ID 01A AREA 20

FRACTION 01A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

AREA

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	474.	3
Titanium	ICP	26.	1
Magnesium	ICP	2770.	22
Manganese	ICP	260.	1
Barium	ICP	221.	1
Aluminum	ICP	4107.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.6	0.1
Selenium	FURNACE	0.9	0.2
Strontium	FLAME	150.	5
Lead	FURNACE	17.9	0.1

Received: 12/05/90

Results by Sample

SAMPLE ID 01A duplicate Area 20 FRACTION 01B TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	465.	3
Titanium	ICP	9.	1
Magnesium	ICP	1860.	22
Manganese	ICP	250.	1
Barium	ICP	154.	1
Aluminum	ICP	3360.	13
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.8	0.1
Selenium	FURNACE	1.5	0.2
Strontium	FLAME	180.	5
Lead	FURNACE	14.4	0.1

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Received: 12/06/90

Results by Sample

SAMPLE ID 01A Spike

FRACTION 01C TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	137.	2
Vanadium	ICP	738.	3
Titanium	ICP	139.	1
Magnesium	ICP	4130.	22
Manganese	ICP	453.	1
Barium	ICP	368.	1
Aluminum	ICP	12300.	3
Molybdenum	ICP	154.	4
Arsenic	FURNACE	NA	0.1
Selenium	FURNACE	NA	0.2
Strontium	FLAME	NA	5
Lead	FURNACE	NA	0.1

Received: 12/05/90

Results by Sample

SAMPLE ID 01A Spike Duplicate FRACTION 01D TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst RCM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	139.	2
Vanadium	ICP	791.	3
Titanium	ICP	97.	1
Magnesium	ICP	4540.	22
Manganese	ICP	461.	1
Barium	ICP	408.	1
Aluminum	ICP	13950.	3
Molybdenum	ICP	150.	4
Arsenic	FURNACE	NA	0.1
Selenium	FURNACE	NA	0.2
Strontium	FLAME	NA	5
Lead	FURNACE	NA	0.1

Page 7
Received: 12/06/90

Results by Sample

SAMPLE ID 02A *Area 22*

FRACTION 02A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	NA	2
Vanadium	ICP	105.	3
Titanium	ICP	20.	1
Magnesium	ICP	1300.	22
Manganese	ICP	146.	1
Barium	ICP	86.2	1
Aluminum	ICP	2120.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.8	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	162.	5
Lead	FURNACE	4.1	0.1

Received: 12/05/90

Results by Sample

SAMPLE ID 03A Area 23

FRACTION 03A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	53.4	3
Titanium	ICP	15.0	1
Magnesium	ICP	993.	22
Manganese	ICP	151.	1
Barium	ICP	106.	1
Aluminum	ICP	1830.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.7	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	103.	5
Lead	FURNACE	4.1	0.1

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Received: 12/06/90

Results by Sample

SAMPLE ID 04A *Area 25*

FRACTION 04A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	8.28	3
Titanium	ICP	10.8	1
Magnesium	ICP	612.	22
Manganese	ICP	142.	1
Barium	ICP	76.4	1
Aluminum	ICP	1240.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.5	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	24.3	5
Lead	FURNACE	1.7	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 05A Area 6

FRACTION 05A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst RCM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	186.	3
Titanium	ICP	52.8	1
Magnesium	ICP	1800.	22
Manganese	ICP	226.	1
Barium	ICP	196.	1
Aluminum	ICP	4210.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.8	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	182.	5
Lead	FURNACE	9.2	0.1

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Results by Sample

SAMPLE ID 06A Area 10 FRACTION 06A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	185.	3
Titanium	ICP	40.	1
Magnesium	ICP	2000.	22
Manganese	ICP	229.	1
Barium	ICP	79.	1
Aluminum	ICP	3640.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.8	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	154.	5
Lead	FURNACE	8.3	0.1

Received: 12/06/90
Results by Sample

SAMPLE ID 07A Area 11 FRACTION 07A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	847.	3
Titanium	ICP	15.9	1
Magnesium	ICP	2580.	22
Manganese	ICP	273.	1
Barium	ICP	200.	1
Aluminum	ICP	4320.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.7	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	15.3	5
Lead	FURNACE	26.6	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 08A Wash S. of Residences

FRACTION 08A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	9.63	3
Titanium	ICP	25.3	1
Magnesium	ICP	1154.	22
Manganese	ICP	105.	1
Barium	ICP	58.5	1
Aluminum	ICP	2970.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.4	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	25.5	5
Lead	FURNACE	21.9	0.1

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Results by Sample

SAMPLE ID 09A Road to B-V

FRACTION 09A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/14/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	6.07	3
Titanium	ICP	25.1	1
Magnesium	ICP	1480.	22
Manganese	ICP	2580.	14
Barium	ICP	4930.	1
Aluminum	ICP	3060.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.8	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	35.1	5
Lead	FURNACE	3.9	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 10A *On Road to Desiderio*

FRACTION 10A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	10.4	3
Titanium	ICP	90.3	1
Magnesium	ICP	2170.	22
Manganese	ICP	181.	1
Barium	ICP	124.	1
Aluminum	ICP	5530.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.8	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	22.6	5
Lead	FURNACE	5.9	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 11A Mine Pit Near Corral FRACTION 11A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	5.67	3
Titanium	ICP	41.3	1
Magnesium	ICP	2160.	22
Manganese	ICP	148.	1
Barium	ICP	91.0	1
Aluminum	ICP	3970.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.1	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	64.0	5
Lead	FURNACE	2.4	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 12A Radon Cartridge Areas FRACTION 12A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	11.0	3
Titanium	ICP	23.1	1
Magnesium	ICP	2450.	22
Manganese	ICP	136.	1
Barium	ICP	132.	1
Aluminum	ICP	4000.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	5.2	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	116.	5
Lead	FURNACE	9.5	0.1

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Results by Sample

SAMPLE ID 13A Radon Cart Areas FRACTION 13A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category ______

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	12.7	3
Titanium	ICP	39.8	1
Magnesium	ICP	2440.	22
Manganese	ICP	245.	1
Barium	ICP	104.	1
Aluminum	ICP	3720.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	10.2	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	139.	5
Lead	FURNACE	7.0	0.1

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Results by Sample

SAMPLE ID 14A Station 11 FRACTION 14A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst RFM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	11.2	3
Titanium	ICP	55.1	1
Magnesium	ICP	2049.	22
Manganese	ICP	131.	1
Barium	ICP	69.7	1
Aluminum	ICP	4000.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.4	0.1
Selenium	FURNACE	0.2	0.2
Strontium	FLAME	119.	5
Lead	FURNACE	3.3	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 15A

FRACTION 15A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	9.43	3
Titanium	ICP	60.1	1
Magnesium	ICP	2130.	22
Manganese	ICP	137.	1
Barium	ICP	58.4	1
Aluminum	ICP	4370.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.5	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	129.	5
Lead	FURNACE	3.1	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 16A

FRACTION 16A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	6.85	3
Titanium	ICP	49.5	1
Magnesium	ICP	1500.	22
Manganese	ICP	115.	1
Barium	ICP	62.3	1
Aluminum	ICP	3920.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.0	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	21.3	5
Lead	FURNACE	2.9	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 17A

FRACTION 17A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category ______

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	10.8	3
Titanium	ICP	46.3	1
Magnesium	ICP	1830.	22
Manganese	ICP	143.	1
Barium	ICP	20.5	1
Aluminum	ICP	3450.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.5	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	227.	5
Lead	FURNACE	2.4	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 18A   FRACTION 18A   TEST CODE METALS   NAME METALS ANALYSIS

Date & Time Collected 11/15/90   Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM   UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	7.59	3
Titanium	ICP	28.9	1
Magnesium	ICP	1400.	22
Manganese	ICP	109.	1
Barium	ICP	90.8	1
Aluminum	ICP	3450.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	1.2	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	23.0	5
Lead	FURNACE	3.0	0.1

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Received: 12/06/90

Results by Sample

SAMPLE ID 19A

FRACTION 19A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	89.9	3
Titanium	ICP	12.0	1
Magnesium	ICP	1310.	22
Manganese	ICP	118.	1
Barium	ICP	205.	1
Aluminum	ICP	2120.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.7	0.1
Selenium	FURNACE	<0.2	0.2
Strontium	FLAME	95.0	5
Lead	FURNACE	1.9	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 20A

FRACTION 20A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	95.3	3
Titanium	ICP	10.7	1
Magnesium	ICP	1130.	22
Manganese	ICP	112.	1
Barium	ICP	201.	1
Aluminum	ICP	1740.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	0.8	0.1
Selenium	FURNACE	0.5	0.2
Strontium	FLAME	103.	5
Lead	FURNACE	2.7	0.1

Received: 12/06/90

Results by Sample

SAMPLE ID 21A

FRACTION 21A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/15/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/Kg

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	2
Vanadium	ICP	1410.	3
Titanium	ICP	22.5	1
Magnesium	ICP	1930.	22
Manganese	ICP	225.	1
Barium	ICP	65.0	1
Aluminum	ICP	3320.	3
Molybdenum	ICP	ND	4
Arsenic	FURNACE	6.0	0.1
Selenium	FURNACE	1.4	0.2
Strontium	FLAME	22.6	5
Lead	FURNACE	23.1	0.1

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Received: 12/05/90

Results by Sample

SAMPLE ID W1

FRACTION 22A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	11.7	0.22
Manganese	ICP	.103	0.01
Barium	ICP	ND	0.01
Aluminum	ICP	ND	0.03
Molybdenum	ICP	.052	0.04
Arsenic	FURNACE	0.003	0.001
Selenium	FURNACE	<0.002	0.002
Strontium	FLAME	11.2	0.05
Lead	FURNACE	0.002	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W1 Dulpicate

FRACTION 22B TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	11.2	0.22
Manganese	ICP	.1	0.01
Barium	ICP	ND	0.01
Aluminum	ICP	.19	0.03
Molybdenum	ICP	.05	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	11.0	0.05
Lead	FURNACE	0.002	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W1 Spike

FRACTION 22C TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	0.85	0.02
Vanadium	ICP	0.93	0.03
Titanium	ICP	0.99	0.01
Magnesium	ICP	12.3	0.22
Manganese	ICP	1.0	0.01
Barium	ICP	0.76	0.001
Aluminum	ICP	0.96	0.003
Molybdenum	ICP	1.0	0.04
Arsenic	FURNACE	NA	0.001
Selenium	FURNACE	NA	0.002
Strontium	FLAME	NA	0.05
Lead	FURNACE	NA	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W1 Spike Duplicate

FRACTION 22D TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	0.84	0.02
Vanadium	ICP	0.89	0.03
Titanium	ICP	0.99	0.01
Magnesium	ICP	12.27	0.22
Manganese	ICP	0.99	0.01
Barium	ICP	0.73	0.01
Aluminum	ICP	1.3	0.03
Molybdenum	ICP	1.0	0.04
Arsenic	FURNACE	NA	0.001
Selenium	FURNACE	NA	0.002
Strontium	FLAME	NA	0.05
Lead	FURNACE	NA	0.0001

Received: 12/05/90

TMA Inc. REPORT Work Order # A0-12-025

Results by Sample

SAMPLE ID W2

FRACTION 23A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	2.08	0.22
Manganese	ICP	ND	0.01
Barium	ICP	ND	0.01
Aluminum	ICP	.042	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	ND	0.05
Lead	FURNACE	0.013	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W3

FRACTION 24A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	1.76	0.22
Manganese	ICP	ND	0.01
Barium	ICP	0.03	0.01
Aluminum	ICP	ND	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	0.12	0.05
Lead	FURNACE	ND	

TMA/ARLI 160 Taylor Street / Monrovia, CA 91016 / (818) 357-3247 / FAX (818) 359-5036

Received: 12/06/90

Results by Sample

SAMPLE ID W4

FRACTION 25A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	ND	0.22
Manganese	ICP	ND	0.01
Barium	ICP	0.03	0.01
Aluminum	ICP	ND	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	2.55	0.05
Lead	FURNACE	ND	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W5

FRACTION 26A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90

Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	5.47	0.22
Manganese	ICP	0.03	0.01
Barium	ICP	4.79	0.01
Aluminum	ICP	6.51	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	0.26	0.05
Lead	FURNACE	0.005	0.0001

Received: 12/06/90

Results by Sample

SAMPLE ID W6

FRACTION 27A TEST CODE METALS NAME METALS ANALYSIS
Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	ND	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	ND	0.22
Manganese	ICP	ND	0.01
Barium	ICP	0.03	0.01
Aluminum	ICP	0.03	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	0.12	0.05
Lead	FURNACE	0.006	0.0001

Page 65

Received: 12/05/90

Results by Sample

SAMPLE ID W7

FRACTION 28A TEST CODE METALS NAME METALS ANALYSIS

Date & Time Collected 11/16/90 Category

Date Prepared 12/20/90
Date Analyzed 01/07/91

Analytical Test Results - METALS

Analyst REM UNITS mg/L

ELEMENT	METHOD	RESULT	DETECTION LIMIT
Chromium	ICP	ND	0.02
Vanadium	ICP	0.22	0.03
Titanium	ICP	ND	0.01
Magnesium	ICP	1.61	0.22
Manganese	ICP	0.02	0.01
Barium	ICP	ND	0.01
Aluminum	ICP	1.06	0.03
Molybdenum	ICP	ND	0.04
Arsenic	FURNACE	ND	0.001
Selenium	FURNACE	ND	0.002
Strontium	FLAME	0.12	0.05
Lead	FURNACE	0.006	0.0001

Received: 12/06/90

NonReported Work

FRACTION AND TEST CODES FOR WORK NOT REPORTED ELSEWHERE

01A	I	3050IC	AS_SED	MPREPS
01B	I	3050IC	AS_SED	MPREPS
01C	I	3050IC	AS_SED	MPREPS
01D	I	3050IC	AS_SED	MPREPS
02A	I	3050IC	AS_SED	MPREPS
03A	I	3050IC	AS_SED	MPREPS
04A	I	3050IC	AS_SED	MPREPS
05A	I	3050IC	AS_SED	MPREPS
06A	I	3050IC	AS_SED	MPREPS
07A	I	3050IC	AS_SED	MPREPS
08A	I	3050IC	AS_SED	MPREPS
09A	I	3050IC	AS_SED	MPREPS
10A	I	3050IC	AS_SED	MPREPS
11A	I	3050IC	AS_SED	MPREPS
12A	I	3050IC	AS_SED	MPREPS
13A	I	3050IC	AS_SED	MPREPS
14A	I	3050IC	AS_SED	MPREPS
15A	I	3050IC	AS_SED	MPREPS
16A	I	3050IC	AS_SED	MPREPS
17A	I	3050IC	AS_SED	MPREPS
18A	I	3050IC	AS_SED	MPREPS
19A	I	3050IC	AS_SED	MPREPS
20A	I	3050IC	AS_SED	MPREPS
21A	I	3050IC	AS_SED	MPREPS
22A	I	3010	AS_SED	MPREPW
22B	I	3010	AS_SED	MPREPW
22C	I	3010	AS_SED	MPREPW
22D	I	3010	AS_SED	MPREPW
23A	I	3010	AS_SED	MPREPW
24A	I	3010	AS_SED	MPREPW
25A	I	3010	AS_SED	MPREPW
[illegible]	I	3010	AS_SED	MPREPW
[illegible]	I	3010	AS_SED	MPREPW
[illegible]	I	3010	AS_SED	MPREPW

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TMA
Thermo Analytical Inc.

TMA/Eberline
7021 Pan American Hwy
Albuquerque, NM 87109
(505) 345-3461

CUSTODY TRANSFER RECORD/ LAB WORK REQUEST

Received By ______ Client E&E Contact ______

Date Shipped 12/4/90 Contact M.S. Philips Date Due 12/27/90

Assigned to HLLI Phone ______ WO Number ______

SAMPLE IDENTIFICATION

ANALYSES REQUESTED

1 of 2

Sample No.	Client ID	Description *		Mat.	Collected	Container								
1A	Area 20	Soil	300 CPM	S	1455 11-14-90		Metals							
2A	22		BKG	S	11-14-90									
3A	23		BKG	S	11-14-90									
4A	25		BKG	S	1540 11-14-90									
5A	6		200 CPM	S	1610 11-14-90									
6A	10		80 CPM	S	1622 11-14-90									
7A	11		300 CPM	S	1635 11-14-90									
8A	wash area S. of Res.		BKG	S	1650 11-14-90									
9A	Road to B-V		BKG	S	11-14-90									
10A	N. Road to Desiderio		BKG	S	0830 11-15-90									
11A	mud flat near Canal		BKG	S	1005 11-15-90									
12A	Radar cartridge areas		BKG	S	1125 11-15-90									
13A	Radar cartridge areas		BKG	S	1125 11-15-90									
14A	sta. 11		BKG	S	1210 11-15-90									
15A			BKG	S	1215 11-15-90									
16A			BKG	S	1249 11-15-90									
17A	sta 10		BKG	S	1255 11-15-90									
18A			BKG	S	1425 11-15-90									
19A			BKG	S	1515 11-15-90									
20A			BKG	S	1520 11-15-90									

Matrix:
S-soil DL-drum liquid DS-drum solid
W-water B-bio samples X-other

Special instructions:

*RM14S

Item/Reason	Relinquished By	Received By	Date	Time	Item/Reason	Relinquished By	Received By	Date	Time
		D. Wells	12/6/90						

TMA
Thermo Analytical Inc.

TMA/Eberline
7021 Pan American Hwy
Albuquerque, NM 87109
(505) 345-3461

CUSTODY TRANSFER RECORD/ LAB WORK REQUEST

Received By ______________ Client ______________ Contact ______________
Date Shipped ______________ Contact ______________ Date Due ______________
Assigned to ______________ Phone ______________ WO Number ______________

SAMPLE IDENTIFICATION

ANALYSES REQUESTED

Sample No.	Client ID	Description *		Mat.	Collected	Container								
21A	STA 40	Soil	800 CPM	S	1540 11-15-90		METALS							
W1	E & E	Water	BKG	W	11-16-90									
W2	E & E		BKG	W	11-16-90									
W3	B-V TAP Water		BKG	W	0910 11-16-90									
W4	B-V Well		BKG	W	0905 11-16-90									
W5	Desiderio Stock Pond		BKG	W	0935 11-16-90									
W6	Desiderio Tap Water		BKG	W	0955 11-16-90									
W7	Preschool Well		BKG	W	1105 11-16-90									

Matrix:
S-soil DL-drum liquid DS-drum solid
W-water B-bio samples X-other

Special instructions:

* RM145

Item/Reason	Relinquished By	Received By	Date	Time	Item/Reason	Relinquished By	Received By	Date	Time
		[illegible signature]	12/4/90						

APPENDIX C

Laboratory Preliminary Results

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

CUSTOMER Ecology and Environment

ADDRESS 160 Spear Street #930

CITY San Francisco Ca. 94105

CUST. P.O. NO. [illegible]

PROJ # ZT1091 E0970195AA

Attn: Mary Sue Philp Ph# (415) 777-2811

E2732

ITEM	NO. OF SAMPLES	TYPE OF ANALYSIS
1	7	Water - Radium 226/8, Isotopic Uranium

LAB NO.	CUSTOMER IDENTIFICATION	CUSTOMER SAMP. NO.	DATE COLLECTED	TYPE OF ANALYSIS	ml			pCi/l
E500	B-V Livestock well	W1	0830 11-16-90	Ra^{226}	3839.3 ml			0.8 ± 0.
				Ra^{228}	3840			0 ± 5
				$U^{233/4}$				2.0 ± 0.
				U^{235}				0.3 ± 0.1
				U^{238}				0.4 ± 0.
01	B-V Livestock well	W2	0855 11-16-90	Ra^{226}	2708.3			0.2 ± 0.1
				Ra^{228}	2710			0 ± 5
				$U^{233/4}$				0.5 ± 0.
				U^{235}				0.0 ± 0.1
				U^{238}				0.0 ± 0.1
02	B-V Tap Water	W3	0910 11-16-90	Ra^{226}	3961.9			0.2 ± 0.1
				Ra^{228}	3960			0 ± 5
				$U^{233/4}$				2.1 ± 0.
				U^{235}			PB 1-14-91	~~0.9~~ 1.0 ± 0.
				U^{238}				0.8 ± 0.

RTP acidified + filtered 11/16/90

* INSERT UNITS

A-FAX 1-14-91 need Ra226 (To E+E, Fiso, EPA)

BY Paul Kur[illegible] 1/16/[illegible] DATE

PB 12-4-90

1 2

TMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

CUSTOMER Ecology & Environment

ADDRESS

CITY

E2732

E503	B-V Well	W4	11-16-90	Ra^{226}	3865.1			0.1±0.1
				Ra^{228}	3870			0±5
				U^{234}				1.4±0.
				U^{235}				0.5±0.
				U^{238}				0.5±0.
04	Desiderio Stock Pond	W5	0935 11-16-90	Ra^{226}	3891.4			0.3±0.1
				Ra^{228}	3890			0±5
				U^{234}				2.3±0.
				U^{235}				0.1±0.1
				U^{238}				2.2±0.
05	Desiderio tap Water	W6	0955 11-16-90	Ra^{226}	4054.1			0.3±0.
				Ra^{228}	4050			0±5
				U^{234}				1.2±0
				U^{235}				0.0±0.
				U^{238}				0.2±0.

* INSERT UNITS

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ALBUQUERQUE, NEW MEXICO 87109

BY [signature]

11/16/90
12/5

ALBUQUERQUE LABORATORY

PRELIMINARY DAT REPORT

E2132

CUSTOMER Ecology & Environment

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LAB NO.	CUSTOMER IDENTIFICATION							
E506	Preschool Well	W7	11:05 11-16-90	Ra^{226}	3690.1			1.0 ± 0.1
				Ra^{228}	3690			22 ±
				$U^{233/4}$				130 ± 1(
				U^{235}				3.0 ± 0.
				U^{238}				74 ± 7
T 5208	Dup			Ra^{226}				
				Ra^{228}				
				$U^{233/4}$				
				U^{235}				
				U^{238}				
T 09	Blank			Ra^{226}				
				Ra^{228}				
				$U^{233/4}$				
				U^{235}				
				U^{238}				
T 10	Spike			Ra^{226}				
				Ra^{228}				
				$U^{233/4}$				
				U^{235}				
				U^{238}				

* INSERT UNITS

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7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109
PHONE (505) 345-3461

BY PDK

11/16/9

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

CUSTOMER Ecology and Environment
ADDRESS 160 Spear Street #930
CITY San Francisco CA. 94105

CUST. P.O. NO. [illegible]
PROJ # ZT1091 E0920195AA – Project Name: Navajo Selected Mine – uranium site
ATTN: Mary Sue Philp

E2808

ITEM	NO. OF SAMPLES	[illegible]
1	18	Soil - Radium 226/8, Isotopic Uranium

LAB. NO.	CUSTOMER IDENTIFICATION	[illegible]	DATE COLLECTED	TYPE OF ANALYSIS	[illegible]	[illegible]		[illegible]
E948	1A *	Area 20	11-14-90 (1435)	Ra^{226}	518/464			300 ± [illegible]
				Ra^{228}				1 ± 1
				$U^{233/4}$				240 ± 2[illegible]
				U^{235}				13 ± 1
				U^{238}				250 ± [illegible]
49	2A	22	11-14-90	Ra^{226}	570/549			34 ± 3
				Ra^{228}				0 ± 1
				$U^{233/4}$				25 ± 2
				U^{235}				1.0 ± 0.[illegible]
				U^{238}				25 ± [illegible]
50	3A	23	11-14-90	Ra^{226}	480/447			24 ± 2
				Ra^{228}				0 ± 1
				$U^{233/4}$				21 ± 2
				U^{235}				0.8 ± 0.[illegible]
				U^{238}				20 ± [illegible]

* INSERT UNITS

TMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109

12-4-90

BY Paul Kirk[illegible]

12/4/[illegible]

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

E2808

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LAB NO.	CUSTOMER IDENTIFICATION	CONTAINER/SAMPLE NO.	DATE COLLECTED	TYPE OF ANALYSIS		ALIQUOT		
E951	4A	Area 25	1530 11-14-90	Ra^{226}	478/439			4.7±0
				Ra^{228}				0±1
				$U^{233/4}$				3.4±0.
				U^{235}				0.1±0
				U^{238}				3.5±0
52	5A	6	1610 11-14-90	Ra^{226}	591/556			49±5
				Ra^{228}				0±1
				$U^{233/4}$				24±2
				U^{235}				1.0±0.2
				U^{238}				25±2
53	6A	10	1622 11-14-90	Ra^{226}	486/424			130±10
				Ra^{228}				0±1
				$U^{233/4}$				100±1
				U^{235}				4.7±0
				U^{238}				100±10

* INSERT UNITS

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Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.

BY [signature] 12/4/90

TMA/EBERLINE LABORATORY TEL No. 505 761 [illegible]16 Jan 16,91 15:33 P.06

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

E2808

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CUST. P.O. NO.

ITEM	NO. OF SAMPLES	

LAB NO.	CUSTOMER IDENTIFICATION							
E954	7A	Area 11	11-14-90	Ra^{226}	612/610			260±30
				Ra^{228}				1±1
				U^{234}				290±3
				U^{235}				20±2
				U^{238}				310±3
55	8A	Washana S. of Res.	1650 11-14-90	Ra^{226}	522/497			1.9±0.2
				Ra^{228}				1±1
				U^{234}				1.1±0.2
				U^{235}				0.0±0.1
				U^{238}				1.1±0.2
56	9A	Road to B-V	11-14-90	Ra^{226}	563/570			0.8±0.1
				Ra^{228}				0±1
				U^{234}				0.6±0.1
				U^{235}				0.0±0.1
				U^{238}				0.7±0.1

* INSERT UNITS

BY PDK DATE 12/4/90

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PRELIMINARY DATA REPORT

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ITEM	NO. OF SAMPLES	

LAB. NO.	CUSTOMER IDENTIFICATION							
E957	10A	M 22-10 Residence	0830 11-15-90	Ra^{226}	430/343			1.3±0.1
				Ra^{228}				0±1
				$U^{233/4}$				0.6±0.
				U^{235}				0.0±0.
				U^{238}				0.8±0.
58	12A	Radon Cat. areas	1125 11-15-90	Ra^{226}	487/454			34±3
				Ra^{228}				0±1
				$U^{233/4}$				19±2
				U^{235}				1.5±0.2
				U^{238}				19±2
59	13A	11	1125 11-15-90	Ra^{226}	505/474			30±3
				Ra^{228}				0±1
				$U^{233/4}$				17±2
				U^{235}				0.7±0.
				U^{238}				17±2

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DATE

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E960	14A	Sta 11	1210 11-15-90	Ra^{226}	426/391			1.8±0.2
				Ra^{228}				0±1
				$U^{233/4}$				0.6±0.
				U^{235}				0.0±0.
				U^{238}				0.7±0.
61	15A	11	1215 11-15-90	Ra^{226}	436/401			3.0±0.
				Ra^{228}				0±1
				$U^{233/4}$				1.7±0.
				U^{235}				0.0±0.
				U^{238}				1.5±0.2
62	18A	Sta 10	1425 11-15-90	Ra^{226}	453/423			0.8±0.1
				Ra^{228}				0±1
				$U^{233/4}$				0.7±0.1
				U^{235}				0.1±0.
				U^{238}				0.8±0.

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Thermo Analytical Inc.
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ALBUQUERQUE, NEW MEXICO 87109

BY [signature] 12/4/9

5-7

ALBUQUERQUE LABORATORY

PRELIMINARY DATA REPORT

CUSTOMER Ecology & Envirnment

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E2808

LAB NO.	CUSTOMER IDENTIFICATION	CUSTOMER SAMPLE NO.	DATE COLLECTED	TYPE OF ANALYSIS	[illegible]	ALIQUOT		[illegible]
E963	19A	Sta. 10	1515 11-15-90	Ra^{226}	551/533			20±2
				Ra^{228}				0±1
				$U^{233/4}$				28±3
				U^{235}				1.2±0.
				U^{238}				28±3
64	20A	11	1520 11-15-90	Ra^{226}	576/559			33±3
				Ra^{228}				0±1
				$U^{233/4}$				29±3
				U^{235}				1.3±0.2
				U^{238}				28±3
65	21A	Sta. 40	1540 11-15-90	Ra^{226}	543/508			450±5
				Ra^{228}				0±1
				$U^{233/4}$				330±3
				U^{235}				29±
				U^{238}				390±

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Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109

BY PDK

12/4/90

ZTI091 | GROUP URANIUM SITE
(092419SAA)

AMPLERS: (Signature)

TA. NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Radionuclides	Metals					REMARKS
1A	11/14/90	1455	X		Area 20	2x8oz	X	X					
2A	↓	~~1515~~ 1515			Area 22	↓	X	X					Time: 1515
3A		~~1540~~			Area 23		X	X					Time: 1530
4A		1540			Area 25		X	X					
5A		1610			Area 6		X	X					
6A		1620			Area 10		X	X					
7A		1625			Area 11		X	X					
8A	↓	1650	↓		Wash Area South of Residences	↓	X	X					
9A	11/14/90				Road to B-V	2x8oz	X	X					* Direct questions and invoice to Mary Sue Philp Ecology & Environment, Inc. 160 Spear Street Ste. 930 San Francisco, CA 94105 (415) 777-2811

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[signature]	11/16/90 15:35				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

9 12552

[illegible] 1:492@195AF	Navajo Desiderio Group Uranium Site	NO. OF CON- TAINERS	Radionuclides	Metals					REMARKS

SAMPLERS: (Signature) [signatures]

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	Radionuclides	Metals					REMARKS
10A	11/15/90	0830	X		On road to Desiderio	2x8oz	X	X					
11A	↓	1005	X		Mine Pit Near Corral	1x8oz		X					Station #4 @ Desiderio site
12A		1125	X		Radon Cartridge Areas	2x8oz	X	X					Station #7 "
13A		1125	X		Radon Cartridge Areas	2x8oz	X	X					Duplicate of 12A
14A		1210	X		Station 11 Desiderio	2x8oz	X	X					
15A		1215	X		Station 12 "	2x8oz	X	X					
16A		1249	X		Station #9 "	1x8oz		X					
17A		1255	X		Station 10 "	1x8oz		X					
18A		1425	X		Drainage off station #30 @ DV	2x8oz	X	X					*Direct questions and invoice
19A		1515	X		Station #36 " Site.	2x8oz	X	X					to Mary Sue Philp
20A		1520	X		(Dup. of 19A)	2x8oz	X	X					(415) 777-2811
21A	↓	1540	X		Station 40	2x8oz	X	X					160 Spear Street Ste 930
													San Francisco, CA 94105

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[signature]	11/16/90 1540				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

9 12560

Office of Enforcement

CHAIN OF CUSTODY RECORD

San Francisco, California 94105

PROJ. NO. 091 TZ019SAH

PROJECT NAME: Navajo Desiderio Group Uranium Mine

SAMPLERS: (Signature) Vicki Radovld [signature]

NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Radionuclides	Metals					REMARKS
1	11/16/90	0830		X	B-V Livestock Well	1x1gal 1x1QT	X	X					
2	↓	0835		↓	B-V Livestock Well	1x1gal 1x1QT	X	X					
3		0910			B-V Tap Water	↓	X	X					
4		0905			B-V Well		X	X					Gallon containers are for
5		0935			Desiderio Stock Pond		X	X					radionuclide analyses; Quart
6		0955			Desiderio Tap Water		X	X					containers are for metals analysis
7	11/16/90	1105		X	Preschool Well	1x1gal 1x1QT	X	X					

* Direct Questions and invoice to
Mary Sue Philp
Ecology + Environment
160 Spear Street #930
San Francisco, CA 94105
(415) 777-2811

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[signature]	11/16/90 15:35				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)

Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks

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U.S. GOVERNMENT PRINTING OFFICE 1990—787-494-39099

9 12559

Received: 12/06/90 01/21/91 15:49:23

SAMPLE IDENTIFICATION

19	19A
20	20A
21	21A
22	W1
22	W1 Dulpicate
22	W1 Spike
22	W1 Spike Duplicate
23	W2
24	W3
25	W4
26	W5
27	W6
28	W7

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 11

P. ANTONIO MARCH'92

DEPARTMENT OF HEALTH & HUMAN SERVICES

lic Health Service
Health Services Administration

Navajo Area
Indian Health Service
P. O. Box G
Window Rock, Arizona 86515

May 09, 1991

Rosita Loretta
Baca Chapter Coordinator
P.O. Box 127
Prewitt, New Mexico 87045

Dear Ms. Loretto:

Per request, on February 25, 1991, radiochemistry water quality samples were taken from the livestock windmill well number 16T521 next to the Head Start School in Haystack.

Analytical results of the samples are attached and are summarized below:

Analysis	Results	Max Allowable
Ra-226/228	0 pCi/L	5 pCi/L
G-Alpha	15.5 pCi/L	15 pCi/L

The Radium results are well below EPA drinking water standards, however, the Gamma-Alpha results are slightly above the standard. Additionally, the water from this well is not treated in any way for bacteria or other contaminants. While this water may be suitable for livestock, it is unsuitable for humans. Therefore, it is recommended that chapter members not use the water from this well for human consumption.

We have notified Water Resources in Crownpoint and requested they re-paint clearly the "LIVESTOCK USE ONLY" sign on the water storage tank.

Please communicate the contents of this letter to all chapter members. If you have any questions regarding this matter, please call Mr. Peter Fant or Thomas Hill at 505/786-5291, extension 403. Your cooperation is appreciated.

Respectfully,

Charles O. Dowell
Director, OEHE

xc: CHR/Baca
Crownpoint WRD
Fort Defiance WRD
Gallup District

STATE OF NEW MEXICO HEALTH AND ENVIRONMENT DEPARTMENT

SCIENTIFIC LABORATORY DIVISION Area of 11 copy 4/15/91

P.O. Box 4700 700 Camino de Salud, NE

Albuquerque, NM 87196-4700 [505]-841-2500

RADIOCHEMISTRY SECTION [505]-841-2574

April 15, 1991

Request
ID No. 012140

ANALYTICAL REPORT
SLD Accession No. RC-91-0037

Distribution
( ) User 81230
(■) Submitter 310
(※) SLD Files

To: Harry A. Doutt
U.S.PHS; Navajo Area IHS-OEH/
Sanitation Facilities Construction
P. O. Box 648
Ft. Defiance, AZ 86504

From: Radiochemistry Section
Scientific Laboratory Div.
700 Camino de Salud, NE
Albuquerque, NM 87106

Re: A water sample submitted to this laboratory on February 25, 1991

DEMOGRAPHIC DATA

COLLECTION		*LOCATION*
On: 20-Feb-91	*By:* Fan . . .	Well 16T521
At: 12:00 hrs.	*In/Near:* McKinley County	

ANALYTICAL RESULTS

Analysis	Value	Sigma	D. Lmt.	Units	Analyst
G-Alpha w/ Am-241 ref.	40.00	3.00	0.70	pCi/L	Maloy
G-Alpha w/ U-nat ref.	47.00	4.00	1.10	pCi/L	Maloy
G-Beta w/ Cs-137 ref.	13.60	2.30	1.30	pCi/L	Maloy
G-Beta w/ Sr/Y90 ref.	13.20	2.20	1.30	pCi/L	Maloy
U--Chem, Fluoro, uG/L	35.00	7.00	5.00	uG/L	Bitner
assuming U-nat conversion	24.50	4.90	3.50	*pCi/L*	*(calculated)*
Ra-226, SDWA Method. .	-0.01	0.04	0.03	pCi/L	Maloy

Notations & Comments:

Uncertainties, sigmas, are expressed as +- one standard deviation, i.e. one standard error.

Small negative or positive values which are less than two(2) standard deviations should be interpreted as: including 'zero'; as 'not detected'; as 'less than the detection limit (<D. Lmt.)' when reported; or 'less than twice the standard deviation'.

Reviewed By: Loren A. Berge
Loren A. Berge, Ph.D. 04/15/91
Supervisor, Radiochemistry Section

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2236
2237

RECEIVED
APR 18 1991
SUPPORT CENTER

RECEIVED
APR 19 91
EHSD-OEH

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 12

P. ANTONIO MARCH'92

Uranium Resources of Northwestern New Mexico

By LOWELL S. HILPERT

GEOLOGICAL SURVEY PROFESSIONAL PAPER 603

Prepared on behalf of the
U.S. Atomic Energy Commission

A description of the stratigraphic and structural relations of the various types of uranium deposits in one of the world's great uranium-producing regions

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

194 (table 3). Ores in limestone are second in importance, having yielded about 4 percent of the total; ores in carbonaceous shale and coal, and in igneous rocks, constitute less than 1 percent of the total.

The uranium: vanadium ratio of the ores generally is about the same regardless of the grade, type, or age of host rock. Where the average grades show marked differences from the general averages, the tonnage is small and the differences are probably not significant.

At the end of 1958, most of the uranium ores from northwestern New Mexico were being processed by six mills which had a total rated capacity of 11,075 tons per day [2]. At the end of 1964, through a property merger and the closure of one mill, the following mills were operating; they had a collective rated capacity of 9,000–10,000 tons per day:

Company	*Location*
Vanadium Corp. of America	Shiprock.
Homestake-Sapin Partners	Grants.
Kermac Nuclear Fuels Corp	Grants.
The Anaconda Co	Bluewater.

GEOLOGIC SETTING

The three physiographic units, or provinces, in northwestern New Mexico are marked by structural and lithologic as well as physiographic characteristics (fig. 1). The northern part of the area in the Colorado Plateaus province is a broad structural as well as topographic depression, the San Juan Basin. It is characterized by a sedimentary fill of marine and continental rocks that totals several thousand feet in thickness and ranges from Paleozoic to Quaternary in age. Locally around the margins of the basin there are intrusive igneous rocks of Tertiary and Quaternary ages. The southern part of the province, the Datil volcanic field, is characterized by an extensive covering of lavas and associated continental sedimentary rocks that totals several thousand feet in thickness. These rocks are mostly Tertiary and Quaternary in age and cover older marine and continental sedimentary rocks which are exposed along the east and north margins of the area.

The part of the area in the Southern Rocky Mountains province consists generally of mountain blocks that have Precambrian cores; these blocks are draped by marine and continental sedimentary rocks, mostly of late Paleozoic and Mesozoic ages, that are several thousand feet thick, and by valley fills and local volcanic piles of Tertiary and Quaternary ages that also are several thousand feet thick.

The part of the area in the Basin and Range province is characterized by northward-trending fault-block mountains and intervening basins. Along the western part of the province and extending northward into the Southern Rocky Mountains province is the Rio Grande trough, a structural depression. It is filled by several thousand feet of continental sedimentary and volcanic rocks of late Tertiary and Quaternary ages. East of the Rio Grande, the fault-block mountains are generally underlain by crystalline rocks of Precambrian age which are capped by eastward-dipping marine and continental sedimentary rocks of late Paleozoic and Mesozoic ages and by continental sedimentary rocks of Tertiary and Quaternary ages. These rocks total several thousand feet in thickness. At the north end of the province the early Tertiary and older rocks are intruded by laccolithic masses of early Tertiary age.

STRATIGRAPHY

The lithology, thickness, areal distribution, and stratigraphic relations of the uranium-bearing and as-

[2] U.S. Atomic Energy Commission press release 222, Feb. 1, 1959, Grand Junction, Colo.

TABLE 3.—*Uranium ores produced from northwestern New Mexico, classified by age and type of host rock, 1950–64*

Host rock: Age	Host rock: Type	Tons of ore	Percent of total tonnage	U_3O_8 (weight percent)	V_2O_5 [1] (weight percent)		$CaCO_3$ [2] (weight percent)	
Tertiary	Igneous rock	9,285	0.1	0.14	0.04	(68)	11.3	(97)
	Sandstone	9,036	.1	.33	.03	(6,877)	1.2	(6,995)
Cretaceous	Sandstone	57,791	.3	.23	.11	(43,920)	.6	(40,273)
	Carbonaceous shale and coal.	6,497	.1	.20	.03	(4,438)	.7	(2,434)
Jurassic	Sandstone	22,035,186	95.4	.22	.13	[3] (2,364,101)	1.2	(2,578,929)
	Limestone	975,497	4.2	.22	.14	(444,965)	80.5	(413,325)
	Limestone and sandstone	4,513	.1	.34	.16	(999)	42.2	(1,848)
Permian	Sandstone	67	.1	.14	.13	(67)	14.0	(59)
	Limestone	1,039	.1	.21	.38	(803)	51.7	(727)
Pennsylvanian	Limestone	183	.1	.12	.10	(183)	11.7	[4] (183)
Total or weighted average		23,099,094	100.6	0.22	[5] 0.13	[5] (2,414,965)	[5] 1.2	[5] (2,626,256)

[1] Numbers in parentheses are tons of ore assayed for V_2O_5.
[2] Numbers in parentheses are tons of ore assayed for $CaCO_3$.
[3] Excludes tonnage for Shiprock district, which for 24,027 tons averaged 2.56 percent V_2O_5.
[4] Probably silicified as well as sandy.
[5] Only the ores in sandstone are reported.

(Harshbarger and others, 1957; Smith, 1954; Rapaport and others, 1952) and generally extend northeastward from Laguna into north-central New Mexico (D. D. Dickey, written commun., 1963). In most places the Entrada rests on the Wingate Sandstone, but at least in the southeastern part of the Laguna district it rests on the Chinle Formation (Kelly and Wood, 1946). Elsewhere in the Laguna district, rocks that have been called Wingate might belong in the Entrada. If they do, the Entrada rests on the Chinle throughout the district (Hilpert, 1963, p. 6–9).

The upper sandy member of the Entrada constitutes the thicker part of the formation and contains the known uranium deposits. It consists of reddish-orange to white fine-grained quartz sandstone and is marked by thick sets of large-scale crossbeds. It ranges in thickness from 80 to about 250 feet, and has a tendency to weather into bold rounded cliffs. The medial silty member, the lower unit in northwestern New Mexico, consists of red and gray siltstone and ranges in thickness from 10 to about 100 feet.

TODILTO LIMESTONE

The Todilto Limestone (Gregory, 1917, p. 55) rests on the Entrada Sandstone and has about the same outcrop pattern. Southward it pinches out along a line that is 10–20 miles south of U.S. Highway 66 (Rapaport and others, 1952). This line trends westward to a point south of Grants and then swings northwestward into Arizona west of Chuska Peak (pl. 1).

The Todilto Limestone consists of two units. The basal unit, which generally ranges in thickness from 10 to 30 feet, consists of thin-bedded gray fine-grained limestone and some thin interbeds of siltstone and is present everywhere the Todilto crops out. The upper unit, which ranges in thickness from 0 to 100 feet, consists of anhydrite and gypsum and crops out along the east side of the San Juan Basin and northeast of the Sandia Mountains and extends under the central part of the basin. (See pl. 3.) Some of the debris in the Todilto consists of volcanic ash (Weeks and Truesdell, 1958). In some places the beds are nearly black, and some fine black carbonaceous material is concentrated locally along bedding planes. Wherever the limestone is pulverized it emits a fetid odor, and this characteristic coupled with the dark color, has led many to speak of the limestone as "petroliferous." Whether or not the limestone contains hydrocarbons and is petroliferous, its content of organic carbon is low, for it only locally contains as much as 1 percent organic carbon and in general averages only a few tenths of 1 percent. The relations of the organic carbon to the uranium deposits is discussed under *"Distribution of Elements in the Todilto Limestone."*

SUMMERVILLE FORMATION

The Summerville Formation (Gilluly and Reeside, 1928, p. 79–80) overlies the Todilto Limestone and has about the same distribution pattern as the Todilto in northwestern New Mexico (J.S. Wright, oral commun., 1958). The Summerville ranges in thickness from 50 to about 225 feet and averages about 150 feet. It consists of reddish-brown and gray fine-grained sandstone and siltstone, whose individual units range in thickness from a few inches to a few feet. South of Grants and south of Laguna, near its south margin, the Summerville contains a basal quartzite-pebble conglomerate (Silver, 1948, p. 78; Hilpert, 1963, p. 12). The bedding is mostly parallel and probably represents near-shore deposition in a shallow marine embayment.

BLUFF SANDSTONE

Overlying the Summerville Formation is the Bluff Sandstone of the San Rafael Group (Gregory, 1938, p. 58–59), which crops out along the west and south sides of the San Juan Basin (Harshbarger and others, 1957, p. 42-43; Freeman and Hilpert, 1956). The Bluff Sandstone is a pale-orange or buff fine- to medium-grained crossbedded sandstone which weathers into bold rounded cliffs similar to those of the Entrada Sandstone. The Bluff ranges in thickness from about 50 feet in western San Juan County to about 300 feet in McKinley and Valencia Counties. In southwestern McKinley County the Bluff grades into the stratigraphically more extensive Cow Springs Sandstone (Harshbarger and others, 1957, p. 48–51) which occupies the entire stratigraphic interval occupied elsewhere by the Todilto Limestone, Summerville Formation, Bluff Sandstone, and part of the overlying Morrison Formation. On plate 1 these units are mapped with Zuni Sandstone in McKinley and Valencia Counties.

MORRISON FORMATION

The Morrison Formation (Cross, 1894, p. 2; Emmons and others, 1896) is the most important host for uranium deposits in northwestern New Mexico. Its distribution is similar to the San Rafael Group, and it originally covered most of the mapped area (pl. 1) and extended into northeastern Arizona, eastern Utah, and southwestern Colorado (Craig and others, 1955, fig. 19, p. 129). The former southern extent of the Morrison in New Mexico is not known because the beds were removed by erosion prior to the deposition of the overlying Dakota Sandstone

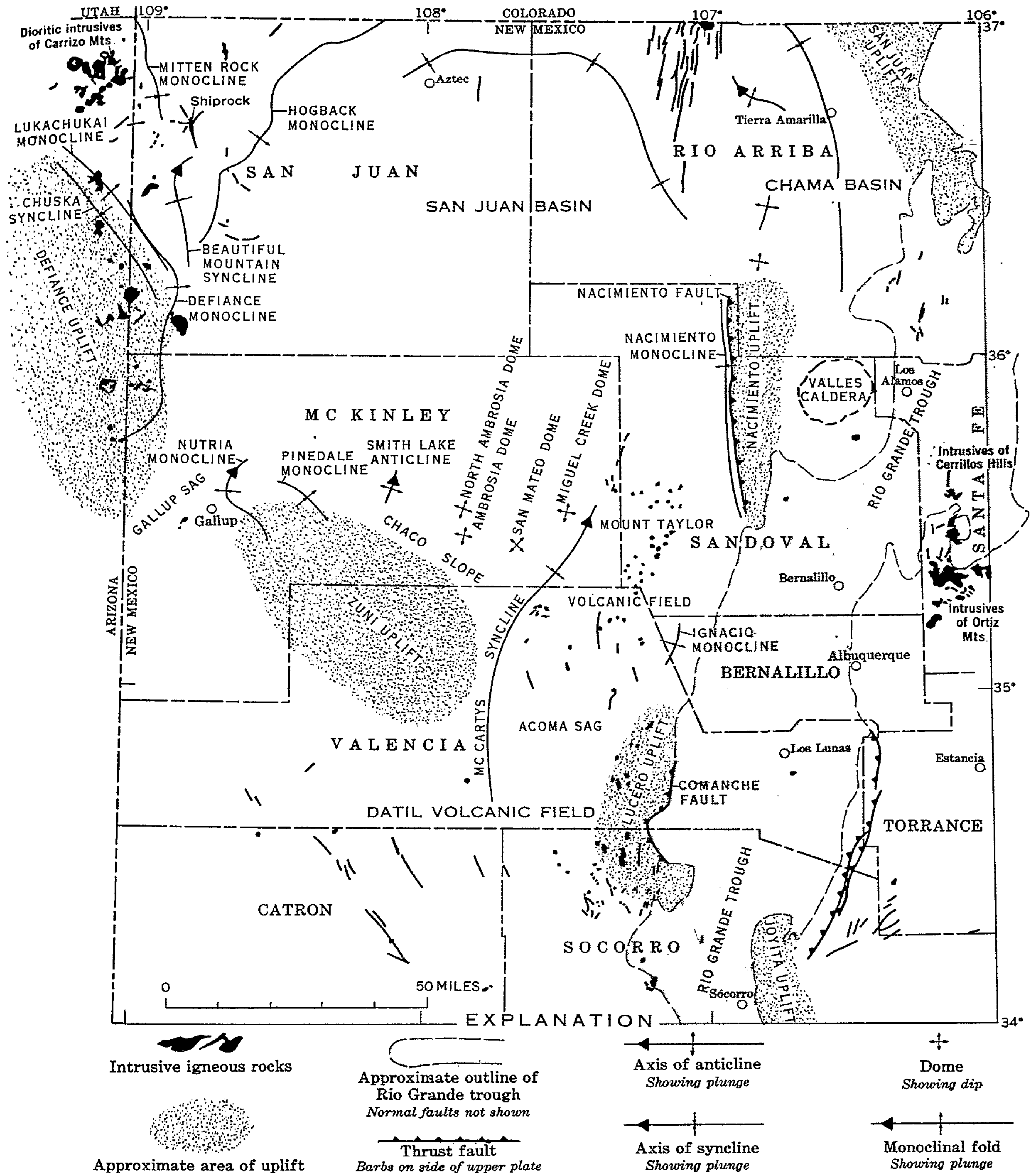


FIGURE 3.—Principal structural elements in northwestern New Mexico and adjoining areas. Modified from Kelley (1954; 1955, fig. 2); O'Sullivan and Beaumont (1957); Dane and Bachman (1957a); and O'Sullivan and Beikman (1963, sheet 2).

draped on their flanks with marine and continental beds of late Paleozoic and Mesozoic ages and some volcanic rocks of Tertiary and Quaternary ages. The rocks of the Rio Grande trough, as farther south, are composed of continental sediments and volcanic debris. The west part of the trough and the east flank of the Sierra Nacimiento are covered by the volcanic pile of the Jemez Mountains which are associated genetically with the Valles caldera.

The principal faults in northwestern New Mexico are concentrated mostly along the periphery of the Rio Grande trough, along the flanks of the ranges of the Southern Rocky Mountains province, and to a lesser extent in the east and northeast flanks of the Zuni uplift and south margin of the San Juan Basin. Most of the faults are normal and high angle and can be traced along the strike for distances of as much as several tens of miles. In the Colorado Plateaus province the faults rarely have a stratigraphic throw of more than a few hundred feet, but in the other provinces the throw on some faults is as much as several thousand feet.

Thrust faults are less common, but one occurs along the west margin of the Southern Rocky Mountains province, and several occur in the Basin and Range province. The most conspicuous thrust fault strikes northward for more than 50 miles along the west flank of the Sierra Nacimiento and the San Pedro Mountains. It dips steeply eastward and generally separates Precambrian crystalline rocks and pre-Triassic sedimentary rocks on the east from Permian and younger rocks on the west (Northrop and other, 1946). Other conspicuous thrusts occur on opposite sides of the Rio Grande trough. One skirts the east flank of Lucero Mesa for a distance of about 20 miles and, at different places along the strike, dips westward from low to high angle, and separates Precambrian and younger rocks on the west from Triassic and younger rocks on the east (Kelley and Wood, 1946). Other thrusts skirt the east flank of the Los Pinos and Manzano Mountains, generally extend along the strike for 10–15 miles, and dip steeply westward. They generally separate Precambrian rocks on the west from Paleozoic rocks on the east (Read and others, 1944; Wilpolt and others, 1946; Wilpolt and Wanek, 1951). The age relations and dating of the various structural features are discussed in the geologic history which follows.

GEOLOGIC HISTORY

The following résumé of the geologic history of northwestern New Mexico is intended to provide a background for understanding the relations of the uranium deposits to the host rocks and to the se mentary, tectonic, and igneous structural featu Where pertinent, more detail is given under descriptions of the mining districts and the ar containing the deposits.

The record of the Precambrian Era is obscure, bu has been long and complex and has been marked deformation, metamorphism, and intrusion by gran and associated rocks. Associated with some of granite in the eastern part of Rio Arriba Cou were injections of uraniferous pegmatite and uran erous fluorite and quartz veins.

The Precambrian rocks subsequently were eroded a peneplain; after this erosion period, the area w probably a stable shelf for most of the Paleozoic E (Kelley, 1955, p. 75). Some marine waters encroac on the northern part of the area at various times, pr ably during the Cambrian and again during Devonian and Mississippian (Bass, 1944; Strob 1958; Baltz and Read, 1960), but the rocks that w deposited are not exposed at the surface and the reco for northwestern New Mexico has been determin only from minimal well data and by projection fr adjacent areas. The rocks that were deposited duri this time interval comprise unnamed Cambrian clastics, the Elbert Formation, the Ouray Limesto and the Leadville Limestone.

During Mississippian time, marine waters a encroached on the eastern part of the area and t limestone and associated clastics of the Caloso Form tion of Kelley and Silver (1952), Kelly Limesto and Arroyo Penasco Formation were deposited.

During late Paleozoic time, two positive structu features began to form; these have persisted interm tently, with modifications, to the present and ha had considerable influence on subsequent geolog events. One of the features, the antecedent of the S Juan uplift and generally known as the San Lu Uncompahgre uplift, was an elongate arch whi began to form in Early Pennsylvanian time (W. Mallory, oral commun., 1963) and which extend from the northeastern part of the area northwestwa into Colorado. The other feature, the antecedent the Zuni and Defiance uplifts, emerged as a bro upwarp about the same time and extended from abo the present position of the Zuni Mountains nort westward into Arizona. Between these two uplifts trough formed in Early Pennsylvanian time that e tended northward through the central part of t area and received marine and continental sediments Pennsylvanian and Permian ages. These sedimenta deposits include, in the southern part of the area, the Sandia Formation, Madera Limestone, Abo and Yeso Formations, Glorieta Sandstone, and San Andres Limestone, and in the northern part of the area, the Molas, Hermosa, Rico, and Cutler Formations. Locally the sedimentation of the upper part of the Madera Limestone and the overlying Abo and Yeso Formations was affected by a positive structural feature that formed in the vicinity of the Joyita Hills (Wilpolt and others, 1946).

Another positive structural feature also was elevated in Pennsylvanian time near the center of the trough and extended northward through the approximate position of the present Nacimiento and San Pedro Mountains area. This structure was antecedent to the Nacimiento uplift, and its position is marked by nondeposition of the upper part of the Madera Limestone and the interbedding of clastic materials with the limestone in the periphery of the uplift (Wood and others, 1946).

The antecedent Zuni and Nacimiento uplifts became buried by Early Permian time and, during the latter part of the Permian and Early Triassic, the Early Permian and older rocks were deformed and beveled. About Middle Triassic time, after the Moenkopi Formation was deposited, the San Juan highlands and other highlands to the southeast of the area were upwarped. Upwarping was accompanied by some volcanic activity elsewhere to the south and southeast of the mapped area (Allen, 1930; Stewart and others, 1959, p. 566).

Northwestern New Mexico at this time was part of a broad plain that sloped westward into Arizona and northwestward into Utah and Colorado. This plain received clastic debris from the highlands to the southeast and northeast and received volcanic debris from the south and southeast; the clastic and volcanic debris formed deposits that now constitute the Chinle Formation and part of the Dockum Formation. The Shinarump Member and Poleo Sandstone Lentil of the Chinle probably had a source in highlands to the south (McKee and others, 1959, p. 22). The northern part of the Agua Zarca Sandstone Member, as recognized by Wood, Northrop, and Cowan (1946), was derived from highlands to the north, and the southern part of the member from highlands to the south (F. G. Poole, written commun., 1957).

Relatively stable conditions existed during Late Triassic and Early Jurassic time and the highland areas were reduced to low relief. On the old flood plain the Wingate and Entrada Sandstones accumulated principally from wind action.

In Late Jurassic time the Zuni uplift was rejuvenated and a broad shallow basin and flood plain was formed to the north. This plain extended into northeastern Arizona, southeastern Utah, and southwestern Colorado. In the basin the Entrada Sandstone, Todilto Limestone, Summerville Formation, Bluff Sandstone (mapped with the Zuni Sandstone on pl. 1), and the Morrison Formation were deposited. The basin was above sea level, except for a time that a shallow embayment opened to the west and permitted entrance of marine waters in which the Summerville Formation and possibly the Todilto Limestone were deposited (Harshbarger and others, 1957; Anderson and Kirkland, 1960). Some volcanic activity, possibly to the southwest of the basin of deposition, accompanied the Morrison deposition.

At the time of deposition of the Jurassic rocks the junction of the uplift, or highland, and the basin areas was within a general zone now marked approximately by the southern outcrop of the Jurassic rocks. This junction is indicated by the depositional margin of the Todilto Limestone (Rapaport and others, 1952), local conglomerate facies of the Summerville on its south margin, general coarsening of the Morrison southward (Craig and others, 1955), and local pinching of the Morrison southward against the Bluff Sandstone (Thaden and Santos, 1957).

While the Jurassic sediments were being deposited, the basin receiving them slowly and differentially subsided as the highland area was rising. These movements caused flexing or broad folding. The flexures occur along the south margin of the San Juan Basin near the probable margin of the old Jurassic basin (Hilpert and Moench, 1960). They probably were concentrated along the marginal zone of the old basin because this would be the zone of maximum differential movement between the basin and the highland area. As the flexures formed, they probably partly controlled the course of the streams that deposited the Morrison sands and influenced the accumulation of the sand units because the foreset beds in the sandstone units show a dominant eastward dip and the sandstone units show an eastward elongation (Rapaport and others, 1952, p. 31–32; Mathewson, 1953; Sharp, 1955, p. 8, 11; Hilpert and Moench, 1960).

The flexing may also have formed local basins in which units like the Jackpile sandstone, of local usage, accumulated (Moench and Schlee, 1959). Such sandstone units contain the largest uranium deposits known in northwestern New Mexico. The flexing may also have helped initiate the development of the Ambrosia dome and other similar structural features in the general vicinity. Moreover, intraformational folds in the Todilto Limestone and pipelike collapse features in sandstones of the Summerville, Bluff, and Morrison Formations probably were caused by or related to this flexing.

In Late Jurassic or Early Cretaceous time the southern highland area and basin margin were tilted upward and beveled, and all formations down to the Abo Formation were progressively cut out southward. Gradual subsidence followed the beveling, and a wide seaway then encroached on the entire area of northwestern New Mexico and adjoining regions. The sea spread gradually from the southeast and the northeast and left a sequence of near-shore continental and shallow marine sediments. These sediments range from the Dakota Sandstone at the base to the Pictured Cliffs Sandstone and total several thousand feet in thickness. Deposition occurred during several transgressions and regressions of the shoreline (Sears and others, 1941); these fluctuations were accompanied by settling of the basin and differential uplift of a rather extensive highland to the southwest which contributed the sediments.

In Late Cretaceous time, as the seas gradually withdrew, the continental Fruitland Formation and Kirtland Shale were deposited. Probably late in this interval, tectonic activity, accompanied by volcanism, in the San Juan Mountains area marked the emergence of the San Juan uplift (Hayes and Zapp, 1955). About the same time or shortly thereafter, the Defiance, Zuni, Lucero, and Nacimiento uplifts emerged, which caused the initial shaping of the San Juan basin; the filling of the basin then progressed by deposition of the continental beds of the Ojo Alamo Sandstone, Animas, Nacimiento, and San Jose Formations from debris shed by the uplifts. A pulselike rise of the uplifts is indicated by the beveling of the older formations by the younger around the basin margins (Hunt, 1956, p. 23–24).

The Late Cretaceous and early Tertiary tectonic events, generally referred to as the Laramide orogeny, are important in helping establish the ages of emplacement of many of the uranium deposits. Structural features that formed during this interval are the monoclinal folds on the basin sides of the uplifts that are marginal to the San Juan Basin, the depressions, or sags, between the adjacent uplifts, and the faults related to the development of these features. These features probably formed in accompaniment with the marked rise of the uplifts that flank the basin. This interval is dated by the Nacimiento Formation of Paleocene age which was deposited during initial deepening of the basin. This deepening was largely concluded by the time of deposition of the San Jose Formation of early Eocene age which lies across the beveled beds of the Nacimiento Formation.

Structural features related to this age of tectonism are the Defiance, Nutria, and other similar monoclinal folds, the Acoma and Zuni sags, and the McCartys syncline and the faults, fractures, and related folds along the syncline's western flank.

Thrust faults probably formed during this time (Wood and others, 1946; Kelley and Wood, 1946; Wilpolt and Wanek, 1951). Some normal faults may also have formed as early as the thrusts, but the normal faults generally are younger because they displace the thrusts (Kelley and Wood, 1946; Wilpolt and Wanek, 1951) and generally range in age from early Tertiary to Quaternary.

After the San Jose Formation was deposited, tilting of the San Juan Basin northward reversed the dip direction of the San Jose (Hunt, 1956, p. 25, 57). Some folding or faulting may have accompanied this tilting and perhaps the McCartys syncline and associated folds and fractures evolved at this time (Hunt, 1938, p. 75), and the Ambrosia dome and other similar structural features were accentuated. It seems more reasonable, however, to relate all these structural events with the preceding rise of the uplifts rather than tie them to simple tilting. The tilting and related events occurred in the post-early Eocene pre-late Miocene time interval because they postdate the San Jose Formation and precede the faulting of the Santa Fe Group along the Rio Grande trough.

In late early Tertiary time, probably during the Oligocene, volcanic activity began in the east-central part of the area and was followed in late Tertiary and Quaternary time by intermittent but widespread volcanic activity throughout much of northwestern New Mexico. The early activity left the laccolithic intrusives and associated volcanic rocks of the Ortiz Mountains and Cerrillos Hills and the dioritic intrusives of the Carrizo Mountains.

The late Tertiary and Quaternary activity left the extensive Datil-Mount Taylor volcanic field, the intrusive bodies, flows, pyroclastic rocks, and outwash debris along the Rio Grande trough, and the dikes, sills, necks, and flows around the periphery of the San Juan Basin.

The Espinaso Volcanics probably were deposited during the Oligocene, about the same time that the intrusive rocks of the Ortiz Mountains and Cerrillos Hills were emplaced (Stearns, 1943, p. 309; Disbrow and Stoll, 1957, p. 10–12, 33–34). These events were probably closely followed by emplacement of the base-metal deposits in the Los Cerrillos district (Lindgren and others, 1910, p. 167; Disbrow and Stoll, 1957, p. 46). Possibly about the same time, and somewhat later, the Datil Formation and related intrusive rocks were emplaced (Winchester, 1920, p. 9; Wilpolt and others, 1946). Late in this episode or soon thereafter, the base- and precious-metal vein and replacement deposits of the several mining districts in Socorro County were formed (Lindgren and others, 1910, p. 255; Loughlin and Koschmann, 1942, p. 56).

The dioritic and partly laccolithic intrusives of the Carrizo Mountains intrude the Mancos Shale, so are certainly Late Cretaceous or younger. More specifically their age is based indirectly on ages determined for similar intrusives elsewhere in the Colorado Plateau and adjacent areas. The oldest age for such rocks was considered to be Late Cretaceous for some of the intrusives in the La Plata Mountains of southwestern Colorado. Shoemaker (1956, p. 162) based this age on the correlation of diorite porphyry debris in the McDermott Member of the Animas Formation, assumed to have been derived from the La Platas. Other dates are younger and firmer. On geomorphic evidence, Hunt, Averitt, and Miller (1953, p. 212) inferred the Henry Mountains intrusives of south-central Utah to be middle Tertiary in age. The laccoliths of the West Elk Mountains in west-central Colorado are Eocene in age or younger because they intrude the Wasatch Formation (Godwin and Gaskill, 1964). More recently, isotopic age dates indicate that the La Sal Mountains laccoliths in southeastern Utah are late Oligocene to Miocene in age (Stern and others, 1965). The laccolithic intrusives of the Ortiz and Cerrillos Hills, which lie immediately southeast of the Colorado Plateau (fig. 3), also fit this general age pattern. They intrude the Galisteo Formation of late Eocene age (Stearns, 1943, p. 309) and are considered to be Oligocene in age (Disbrow and Stoll, 1957, p. 10–12, 33). It appears by analogy, therefore, that the dioritic, laccolithic, and related rocks of the Carrizo Mountains are most likely early to middle Tertiary in age, but could possibly be as old as Late Cretaceous.

In late Tertiary time, probably middle or late Miocene, widespread differential movements were initiated that were marked by uplift, some warping, and normal faulting, and these continued intermittently until at least the end of Tertiary time. The displacements defined the structural boundaries between the Basin and Range, Colorado Plateaus, and Southern Rocky Mountains provinces. During this time volcanic activity continued, and from the adjoining uplifts and volcanic centers the Rio Grande trough and adjoining areas received several thousand feet of alluvial and volcanic debris, including the materials in the Popotosa Formation and the Santa Fe Group.

URANIUM DEPOSITS

A uranium deposit as defined for this report is an occurrence that either has a content of 0.02 percent or more U_3O_8 by analysis or contains an identifiable uranium-bearing mineral. Such deposits occur in about 30 formational units, in seven principal lithologic types of host rocks, and in rocks of seven geologic periods. The host rocks and their ages are classified by symbols in plate 1 and, by number, the symbols show the deposits of mine rank. About 500 deposits or groups of deposits are represented, and the name, location, and a brief description of each is given in table 4. The information is summary and, between different deposits, is somewhat variable because of diverse source data and some company restrictions on publication of data on deposits, particularly subsurface data. Reference is made to the published literature for details on the more important deposits.

For descriptive purposes the uranium deposits are broadly classified as peneconcordant and vein types. By far the larger, more productive, and more abundant are the peneconcordant deposits. (Finch, 1959) which occur in sedimentary rocks and are generally concordant with the bedding, but in detail cut across it. The discordance indicates that the deposits were formed after the sediments accumulated. They differ from vein deposits in that fractures and faults have had only a subordinate or indirect influence in controlling them. The deposits occur mostly in sandstone and have been referred to as carnotite-, sandstone-, and plateau-type deposits; they also occur in limestone and in scattered localities in carbonaceous shale and coal. Vein deposits consist of fracture fillings, stockworks, mineralized breccia, and pegmatite occurrences. They occur in sedimentary, igneous, and metamorphic rocks and differ from peneconcordant deposits in their tendency to be controlled principally by fractures and in their general discordance with the bedding of the sedimentary rocks.

PERIOD	EPOCH	COLORADO PLATEAUS PROVINCE: SAN JUAN BASIN (EXCLUDING THE CHAMA BASIN)	COLORADO PLATEAUS PROVINCE: DATIL SECTION	SOUTHERN ROCKY MOUNTAINS AND BASIN AND RANGE PROVINCES, AND THE CHAMA BASIN, COLORADO PLATEAUS PROVINCE: AREA SOUTH OF ALBUQUERQUE	SOUTHERN ROCKY MOUNTAINS AND BASIN AND RANGE PROVINCES, AND THE CHAMA BASIN, COLORADO PLATEAUS PROVINCE: AREA NORTH OF ALBUQUERQUE
Quaternary	Recent and Pleistocene	Unnamed gravels and alluvium	Unnamed gravels and alluvium	Unnamed gravels and alluvium	Unnamed gravels and alluvium, Tuerto Gravel of Stearns (1953), and Puye Conglomerate
Tertiary	Pliocene	Chuska Sandstone (700-900) and unnamed fluvial and lacustrine beds		Santa Fe Group (0-±5,000)	Santa Fe Group (0-±10,000); includes the Ancha, Abiquiu, and Tesuque Formations; volcanic flows and tuffs in upper part
	Miocene		Datil Formation (0-2,000)	Datil Formation (0-2,000) Popotosa Formation (3,000-5,000) Unnamed volcanic flows and tuffs	Cieneguilla Limburgite of Stearns (1953) (0-600)
	Oligocene				Espinaso Volcanics of Stearns (1943) (400-2,000)
	Eocene	San Jose Formation (0-3,000)	Baca Formation (0-1,500)	Baca Formation (80-1,000)	Galisteo Formation (900-4,000) El Rito Formation of Smith (1938)
	Paleocene	Nacimiento Formation (600-1,000) Animas Formation (600-3,000)			
Cretaceous	Late Cretaceous	Ojo Alamo Sandstone (0-400) McDermott Member of Animas Formation (150-200) Kirtland Shale (0-1,200) Fruitland Formation (0-500) Pictured Cliffs Sandstone (70-400) Lewis Shale (0-2,000) Mesaverde Group; southern part: Cliff House Sandstone (100-1,000): includes La Ventana Tongue in northeastern side Menefee Formation (0-2,000) Point Lookout Sandstone (250-350); includes Hosta Tongue in southern part Crevasse Canyon Formation (500-750) Gallup Sandstone (0-250) Mesaverde Group undivided; southern part Mancos Shale (300-2,000)	Mesaverde Group undivided; southern part: Point Lookout Sandstone Crevasse Canyon Formation (±750) Gallup Sandstone (±400) Mancos Shale (75-400)	Mesaverde Group undivided (0-700) Mancos Shale (0-200)	Mesaverde Group undivided (300-1,000) Mancos Shale (±2,000)
	Early(?) Cretaceous	Dakota Sandstone (0-200)	Dakota Sandstone (0-100)	Dakota Sandstone (±100)	Dakota Sandstone (0-200)
		UNCONFORMITY	UNCONFORMITY	UNCONFORMITY	UNCONFORMITY
Jurassic	Late Jurassic	Cow Springs Sandstone (±250) Morrison Formation: Brushy Basin Member (0-600); includes Jackpile sandstone of economic usage in Laguna district and Poison Canyon sandstone of economic usage in Ambrosia Lake district Westwater Canyon Member (0-300) Recapture Member (0-500) Salt Wash Member (0-200); northwestern part Zuni Sandstone (±500); southern part San Rafael Group: Bluff Sandstone (0-350) Summerville Formation (50-225) Todilto Limestone (0-100) Entrada Sandstone (0-300)	Morrison Formation (0-400); northern part only; same nomenclature as in San Juan Basin Bluff Sandstone (0-300); northern part Zuni Sandstone; northern part Lower part of San Rafael Group; same units in northern part as in San Juan Basin		Morrison Formation (300-600): Brushy Basin Member (±250); includes unnamed white sandstone unit at top Westwater Canyon Member (75-150) Recapture Member (100-250) San Rafael Group: Summerville(?) Formation (0-100) Todilto Limestone (0-100) Entrada Sandstone (50-275)
	Middle and Early Jurassic				
Triassic	Late Triassic	Glen Canyon Group: Wingate Sandstone (0-65); western and southern sides Chinle Formation (0-1,600); western and southern parts: Owl Rock Member (0-500) Petrified Forest Member, including Sonsela Sandstone Bed (1,000-1,500) Lower red member (50-400) Shinarump Member (0-100) Nomenclature of Chinle Formation along eastern side of basin same as area north of Albuquerque	Wingate Sandstone (0-300); northern part Chinle Formation (0-1,200); northern part; possibly subsurface in southern part: Petrified Forest Member as used by Stewart (1960) (0-1,250) Lower red member (0-300); northwestern part Shinarump(?) Member (0-100)	Chinle Formation (0-1,000); west of Rio Grande. Few exposures; nomenclature same as southern side of San Juan Basin Dockum Formation (80-500); east of Rio Grande	Chinle Formation (400-1,200): Unnamed siltstone member (200-250) Petrified Forest Member as used by Stewart (1960) (600-1,000) Poleo Sandstone Lentil (50-150) Salitral Shale Tongue (50-125) Agua Zarca Sandstone Member (50-100)
		UNCONFORMITY	UNCONFORMITY		
	Middle(?) and Early Triassic	Moenkopi(?) Formation (0-200); southwestern part	Moenkopi(?) Formation (0-200); northern part		
Permian		De Chelly Sandstone Member and lower part of Cutler Formation (±750); western part Cutler Formation (±1,000); northern part San Andres Limestone (0-125); southern part Glorieta Sandstone (100-200); southern part Yeso Formation (500-750); southern part Abo Formation (±750); southern part Rico Formation (900-1,200); subsurface only in northwestern San Juan County	San Andres Limestone (400-450) Glorieta Sandstone (±200) Yeso Formation (1,000-1,300) Abo Formation (±900)	Bernal Formation (0-50); east of Rio Grande San Andres Limestone (50-400) Glorieta Sandstone (25-200) Yeso Formation (600-1,700) Abo Formation (300-900) Bursum Formation (0-250)	Cutler Formation (500-1,000); north of latitude 36° N. San Andres Limestone (0-50) Glorieta Sandstone (0-100) Yeso Formation Abo Formation (200-700); south of latitude 36° N.
Carboniferous	Pennsylvanian	Hermosa Formation (1,000-1,350); subsurface only in San Juan County Madera Limestone; locally around southern margins; subsurface extent unknown Molas Formation (60-175); subsurface only in northwestern San Juan County	Magdalena Group: Madera Limestone (±1,700) Sandia Formation (±400)	Magdalena Group: Madera Limestone (100-1,500) Sandia Formation (100-350)	Madera Limestone (0-775); flanks of Sierra Nacimiento and San Pedro Mountains Unnamed sandstone and siltstone (0-250), locally in northeastern Rio Arriba County Sandia Formation (0-250), locally in southern Sierra Nacimiento
	Mississippian	Leadville Limestone (0-225); subsurface only in northern San Juan County	Kelly Limestone (0-75)	Kelly Limestone (0-75) Caloso Formation of Kelley and Silver (1952) (0-50)	Arroyo Penasco Formation (0-150)
Devonian	Late Devonian	Ouray Limestone and Elbert Formation (0-600); subsurface only in northwestern San Juan County			
	Middle and Early				

LIST OF MINES AND MAP NUMBER

Deposits from which uranium ores were produced before January 1, 1965, have mine status. In the Ambrosia Lake district, [illegible]posits having a map size larger than the identifying symbol, or are controlled and [illegible] by more than one company, the symbol is centered over the working shaft rather [illegible] centered over the deposit.

Tertiary igneous rocks (⊕)
1. La Bajada

Tertiary sandstone (○)
1. Charley 2 (Jeter)
2. Hook Ranch (Jaralosa)
3. Red Basin 1

Cretaceous sandstone (◑)
1. Becenti
2. Christian 16 (U)
3. Diamond 2 (Largo 2)
4. Junior
5. Midnight 2
6. Section 5 (Westvaco)
7. Silver Spur 1
8. Silver Spur 5
9. Small Stake

Cretaceous shale (◈)
1. Butler Bros. 1
2. Hogback 3
3. Hogback 4
4. Section 3 (Santa Fe Christ)

Jurassic sandstone (●)
1. Alongo
2. Alta
3. Ann Lee (Section 28)
4. BB (Lewis Barton)*
5. BBB (Barton and Begay)*
6. Beacon Hill
7. Begay 1 and 2
8. Black Jack 1
9. Black Jack 2
10. Blue Peak (Garcia 1)
11. Bob Cat (Section 24)
12. Bucky (Jeep 6)
13. CD and S (Section 35)
14. Canyon View*
15. Carl Yazzie 1
16. Carrizo 1*
17. Castle T'sosie
18. Chaves (Cañoncito)
19. Chill Wills
20. Church Rock†
21. Cliffside (Section 36)
22. Collins
23. Cottonwood Butte*
24. Dennet Nezz
25. Dennet Nezz 2
26. Dennet Nezz 3
27. Dog Incline (Dog group, East Malpais)
28. Dysart 1
29. Dysart 2
30. Enos Johnson
31. Enos Johnson 1
32. Enos Johnson 2
33. Enos Johnson 3 (South Peak)
34. Evelyn
35. Foutz 1
36. Foutz 2
37. Foutz 3 YJ (Yellow Jacket)
38. Francis
39. Hogan
40. H. B. Roy 2
41. Horace Ben 1
42. Isabella
43. Jackpile
44. Joe Ben 1
45. Joe Ben 3
46. John Joe 1
47. Junction
48. Kee Tohe
49. King 2
50. King 6 (Troy Rose)
51. King Tutt
52. King Tutt 1
53. King Tutt Point*
54. Lone Star (Plot 9)
55. Lookout Point
56. M-6
57. Malpais
58. Marquez
59. Mary 1
60. Mesa Top 7 (Moe, Davenport Incline)
61. Mesa Top 18 (Holly)
62. Nelson Point
63. Paguate
64. Pat (Dakota)
65. Plot 7 (Lower Oak Springs)*
66. Poison Canyon
67. Rattlesnake 6*
68. Red Rocks*
69. Red Wash Point*
70. Rocky Flats
71. Rocky Flats 2
72. Rocky mine 2*
73. Salt Canyon
74. Sam Point*
75. Sandstone (Section 34)
76. Sandy
77. Section 8 (Centennial)
78. Section 10
79. Section 15
80. Section 17
81. Section 21 (Doris)
82. Section 22
83. Section 23
84. Section 24
85. Section 25
86. Section 29 (Kermac-United)
87. Section 30 (Kermac-Pacific)
88. Section 30 (San Mateo)
89. Section 32
90. Sections 32-33 (West Ranch)
91. Section 33 (Branson)
92. Section 36 (United Western)
93. Shadyside
94. Shadyside 2
95. Silver Bit 7
96. Silver Bit 15
97. Silver Bit 18
98. Taffy
99. Tent
100. Westwater 1
101. Windwhip
102. Woodrow

Jurassic limestone (▲)
1. Barbara J 1 (Barbara J claims 8, 9, 13)
2. Barbara J 3 (Barbara J claims 22 and 23)
3. Billy The Kid (Red Top 1)
4. Black Hawk-Bunney
5. Cedar 1 (Section 20)
6. Christmas Day
7. Crackpot
8. Dalco 1 (Barbara J 2) (Barbara J claims 9 and 10)
9. Double Jerry (Farris 1, Vallejo)
10. F-33 (Section 33)
11. Faith (Section 29)
12. Flat Top 4-Vilatie Hyde
13. Gay Eagle-Red Bluff 8 and 10
14. Glover
15. Hanosh (Section 26)
16. Haystack (Haystack Butte)(Section 19)
17. Haystack 2
18. La Jara
19. Last Chance
20. Lawrence Elkins
21. Lone Pine 3
22. Manol (Section 30)
23. Paisano
24. Red Bluff 3
25. Red Bluff 5
26. Red Bluff 7
27. Red Bluff 9
28. Red Point Lode
29. Rimrock
30. Section 9
31. Section 13 (Bibo)
32. Section 18
33. Section 18
34. Section 19
35. Section 19 (Greer, Warren, and McCormack)
36. Section 19 (Maddox and Teague)
37. Section 21
38. Section 23
39. Section 24
40. Section 25
41. Section 31
42. Section 32
43. Section 33 (Charlotte)
44. Section 36
45. T 2
46. T 10
47. Tom 13
48. Tom Elkins
49. UDC 5
50. Wasson (Box Canyon)
51. Whitecap
52. Zia

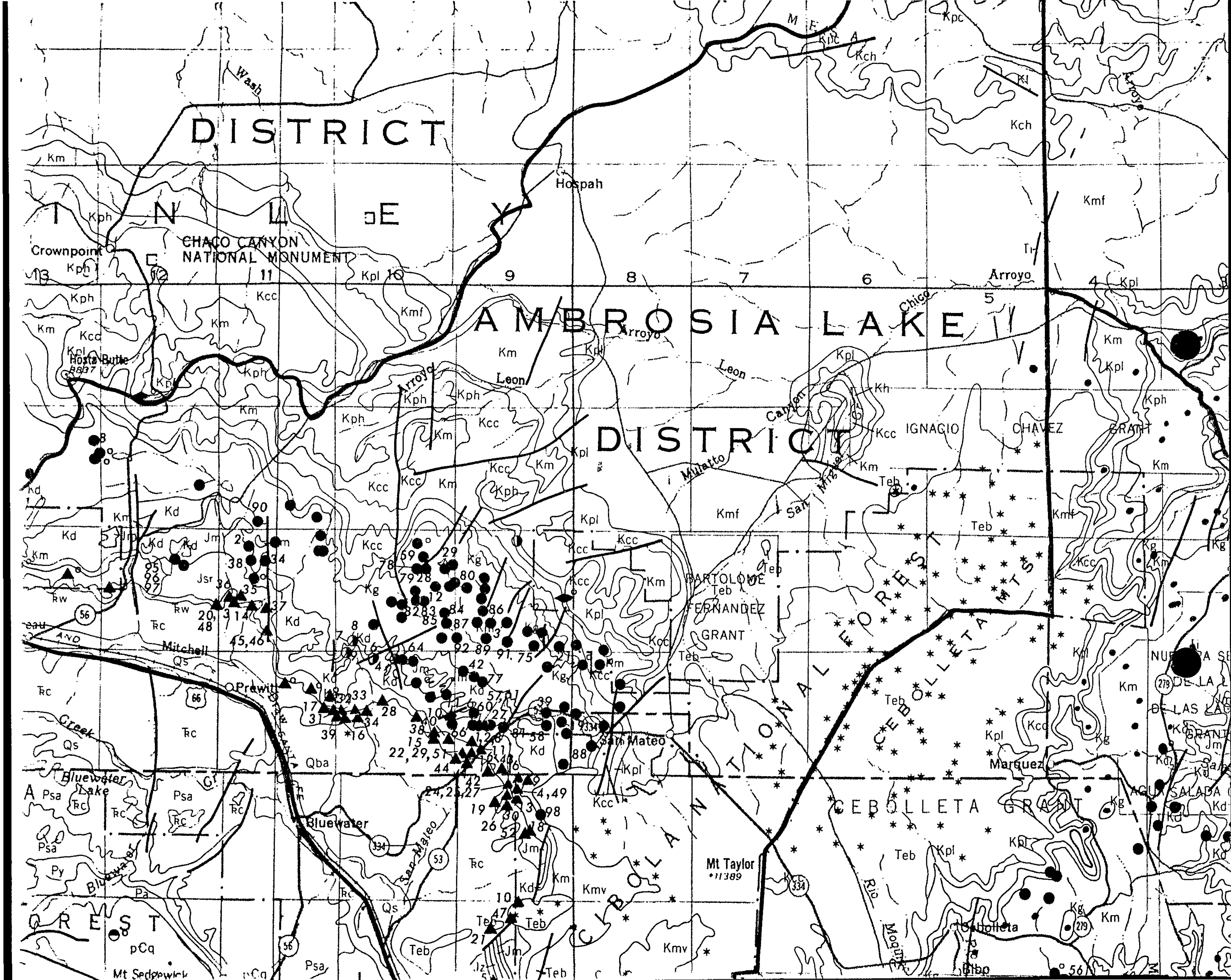
Permian sandstone (◒)
1. Hillfoot 1
2. Red Bird
3. Red Head 2

Permian limestone (▽)
1. Lucky Don (Bonanza 1)
2. Little Davie

Pennsylvanian limestone (△)
1. Agua Torres
2. Marie

*In Shiprock district, but location uncertain and number not plotted.

†Also mined from deposit in Cretaceous sandstone.


DISTRICT
AMBROSIA LAKE
DISTRICT
CHACO CANYON
NATIONAL MONUMENT
Crownpoint
Hospah
Hosta Butte
Prewitt
Bluewater
Bluewater Lake
San Mateo
Mt Taylor
•11389
Mt Sedgwick
IGNACIO
CHAVEZ
GRANT
BARTOLOME
FERNANDEZ
GRANT
CEBOLLETA GRANT
CEBOLLETA MTS
CIBOLA NATIONAL FOREST
Marquez
Cebolleta
Bibo
Mitchell
Arroyo
Chico
Leon
Mulatto
San Miguel
Rio Moquino
Wash
Creek

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 13

P. ANTONIO MARCH'92

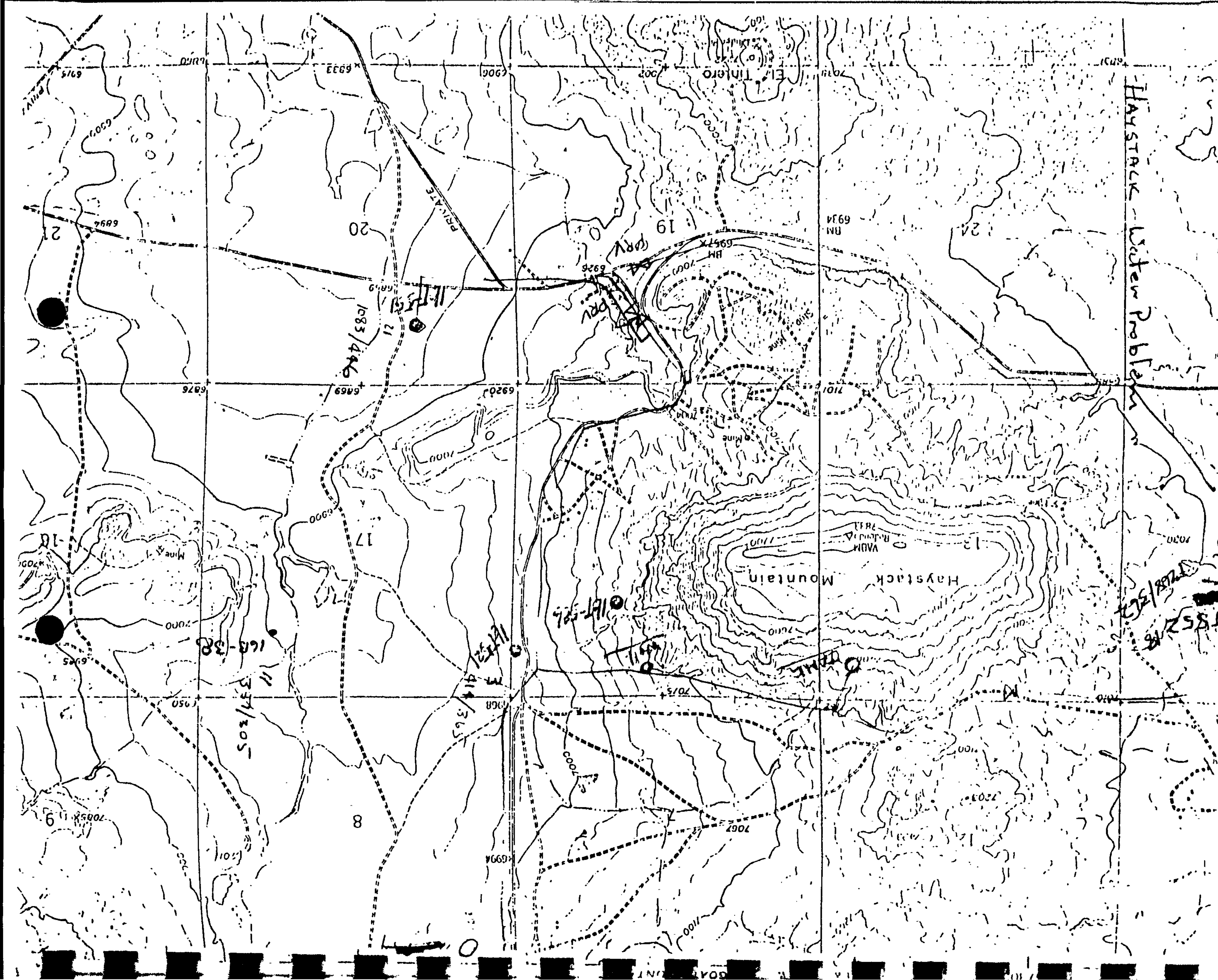
UTM

coordinates for centroid easting = 777975 meters northing = 3915441 mete

search distance from centroid 6500 meters east 6500 meters west
6500 meters north 6500 meters south

window coordinates > minimum east minimum north maximum east maximum north
771475 3908941 784475 3921941

WELLNO	EAST	NORTH	DRILLED	DEPTH	SWL	AQUIFER	OPERATOR
~~00-3289~~	~~780150~~	~~3909728~~	~~/ /~~	~~351.0~~	~~64.0~~	~~231CHNL~~	~~BERRYHILL~~
00-3332	780150	3909728	1/ 1/57	725.0	243.7	313SADG	BERRYHILL
00-3341	773644	3910762	11/ 5/57	200.0	60.4	231CHNL	GIBBS
16B-38	779911	3919037	5/12/36	357.0	331.0	221SMVR	TRIBE O&M
~~16T-521~~	~~778415~~	~~3916770~~	~~11/13/63~~	~~414.0~~	~~365.0~~	~~221ENRD~~	~~TRIBE O&M~~
16T-522	782794	3915615	0/ 0/ 0	270.0	0.0		TRIBE O&M
16T-551	779489	3915538	9/17/69	1083.0	417.0	231SNSL	TRIBE O&M
16T-552	774942	3916262	10/ 9/69	1268.0	362.0	231CHNL	TRIBE O&M
16T-586	778600	3917300	6/18/76	2400.0	47.0		TRIBE O&M



Haystack Water Problem
Haystack Mountain
El Tintero
PRIVATE

TRIBAL WELL RECORD
LOCATION FILE

ENTERED OCT 13 1986 HR

TRIBAL WELL NO [1]6]T]-]5]2]1]]]]]] PWSID [ ]]]]]]]]]]

WELL NAME/OTHER NO [ ]

WELL TYPE (MARK ONE ONLY)	WELL STATUS (MARK ONE ONLY)	WELL USE (MARK ONE ONLY)
(✓)WW WATER WELL	(✓)ACT ACTIVE	( )DOM DOMESTIC
( )WA ARTESIAN WELL	( )INA INACTIVE	( )AGR AGRICULT.
( )WS SPRING	( )ABA ABANDONED	(✓) LIVESTOCK
( )OW OBSERVATION WELL		( )IND INDUSTRIAL MINING
( )GS GAS WELL		( )REC RECREATION
( )OP OIL PRODUCTION		( )MUN MUNICIPAL
( )MW MINERAL WELL		( )OTH OTHER

QUAD NO [1]1]9] MILES WEST [1]0].]5]0] MILES SOUTH [1]0].]0]0]

NE SE SW NW / NE SE SW NW / NE SE SW NW [1]8] [T]1]3].]0]N] [R]1]0].]0]W]
10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE

APPROXIMATE LOCATION [6] M]I]L]E]S] E]A]S]T] O]F] P]R]E]W]I]T]T]]]

[ ]]]]]]]]]]] LATITUDE[3]5]2]1]2]6] LONGITUDE[1]0]7]5]6]1]0]

UTM COORDINATES: X(east)[ ]]]]]]] Y(north)[ ]]]]]]]] ZONE[ ]]

OPERATOR[T]R]I]B]E] O]W]N]] USGS WATERSHED CODE[ ]]]]]]]]]]]]]

STATE: ( )AZ ARIZONA (✓)NM NEW MEXICO ( )UT UTAH ( )CO COLORADO

COUNTY: ( )AP APACHE (✓)MK MCKINLEY ( )SJ SAN JUAN ( )MT MONTEZUMA
( )NA NAVAJO ( )VL VALENCIA ( )KA KANE ( )LP LA PLATA
( )CO COCNINO ( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO GRAZING DISTRICT [1]6]
( )RA RIO ARRIBA
( )SA SAN JUAN

CHAPTER NAME BACA CHAPTER CODE [B]A]C]A]

LOCATION DATA SOURCE: [T]R]I]B]E], B]·]S]T]O]N]E] R]T]-]6]]]]]]]

LOCATION FILE COMPLETED BY: Masud U. Zaman DATE 10/9/1986

FIELD CHECKED BY: [ ]]]]]]]]]]]]]]]]] DATE __/__/__

rev:840425 form:well record loc

TRIBAL WELL RECORD
HYDROLOGY FILE

ENTERED OCT 13 '86 JW.

WELL NO [1|6|T|-|5|2|1| | | | |] USGS AQUIFER CODE [2|2|1| |E|N|R|D]

THICKNESS [| |]FT NOMINAL YIELD [| | |]GPM YIELD MEASURED __/__/__

( )BAILER ( )PUMP TEST @ [| | |3]GPM FOR[| |3|.|0]HOURS DATE 11/13/1963

DRAWDOWN [| | |4|9]FT OBSERVATION WELL DATA AVAILABLE ( )YES (✓)NO

HORIZ CONDUCTIVITY[| | | .| | |]FT/DAY SPECIFIC CAPACITY[|.| |]GPM/FT

VERT. CONDUCTIVITY[| | | .| | |] FT/DAY STORAGE COEF [.| | | | | | |]

COEF OF TRANSMISSIVITY [| | | | | | |] FT2/DAY

INDICATE ADDITIONAL PUMPING TEST DATA AVAILABLE AS HARD COPY:
( )Y ( )N MULTIPLE RATE DRAWDOWN PUMPING TEST
( )Y ( )N SINGLE RATE DRAWDOWN PUMPING TEST
( )Y ( )N MULTIPLE RATE DRAWDOWN/RECOVERY TEST
( )Y ( )N RECOVERY TEST

LOGS AVAILABLE: (✓)DL DRILLER'S LOG ( )EL ELECTRIC LOG

HYDROLOGY DATA SOURCE: [T|R|/|S|E| | | | | | | | | | | | | | | | | | |]

HYDROLOGY FILE COMPLETED BY: ______________ M. Z. DATE 10/9/1986

JW ENTERED OCT 13 '86

STATIC WATER LEVEL FILE

DEPTH TO SWL 365 FT DATE 11/13/1963 DEPTH TO SWL_______FT DATE__/__/__

DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

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DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

DEPTH TO SWL_______FT DATE__/__/__ DEPTH TO SWL_______FT DATE__/__/__

rev:840427 form: well record hyd

TRIBAL WELL RECORD
STRUCTURE FILE

ENTERED OCT 13 1986 JR

WELL NO [1]6]T]-]5]2]1]]]]] STARTED 10/15/1963 COMPLETED 11/13/1963

ELEVATION [ ]7]0]5]0] FT DEPTH [ ]]4]1]4] FT DEPTH MEASURED 11/13/1963

DEPTH IS (✓)MEASURED ( )ESTIMATED ( )REPORTED WELL DIA. [ ]8].]0]0] IN

1 CASING DIA [ ]6].]6]2] FROM[ ]]]0]0]FT TO[ ]]4]1]4]FT MATL[S]T]L]

2 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

3 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

4 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

casing matl codes brs=brass cop=copper evd=everdur irn=iron mon=monel
pls=plastic stl=steel sst=stainless steel

1 CASING PERFORATED FROM [ ]]3]8]0]FT TO[ ]]4]1]4]FT OPENING TYPE [P]

2 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

3 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

4 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

5 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

opening codes: f=fractured rock, l=louvered or shutter-type screen, m=mesh screen, p=perforated,porous,slotted casing, r=wire-wound screen s=screen,type unknown, t=sand point, w=walled or shored, x=open hole z=other

DATE WELL TURNED OVER TO TRIBE: __/__/__

FUNDED BY: [T]R]I]B]E]]]] CONTRACTOR: [T]R]I]B]E]]]]]]]]]]]]

SITE IMPROVEMENTS	TYPE OF LIFT	ENERGY SOURCE
(✓)WM WINDMILL	( )AL AIRLIFT	( )EM ELECTRIC MOTOR
(✓)WP WATERING POINT	(✓)PS PISTON	( )DE DIESEL ENGINE
(✓)TA TANK	( )TU TURBINE	( )HA HAND
( )WL WATER LINE	( )MT MULTIPLE TURBINE	( )GS GAS ENGINE
( )TR TROUGH	( )CN CENTRIFUGAL	( )LP LP GAS ENGINE
( )CS CISTERN	( )MC MULTIPLE CENTRIFUGAL	( )NG NATURAL GAS ENGINE
( )HP HAND PUMP	( )BU BUCKET	(✓)WM WINDMILL
( )NO NONE	( )SU SUBMERSIBLE	( )SO SOLAR

PUMP HP [ ]]]] ON SITE STORAGE CAPACITY [ ]2]7]9]0]0] GAL

STRUCTURE DATA SOURCE: [T]R]I]B]E]]]]]]]]]]]]]]]]]]]

STRUCTURE FILE COMPLETED BY: ____________ M.Z. DATE 10/9/1986

rev:840426 form: well record str

TRIBAL WELL RECORD
COMMENTS FILE

TRIBAL WELL NO [1][6][7]-[5][2][1][ ][ ][ ][ ][ ]

PERTINENT
COMMENTS: water quality information on file.

— Additional 1000 gallons elevated tank for water hauling.

ENTERED OCT 13 1988

rev:840430 form: well record com

WELL RECORD

Water Well Development
Navajo Tribe
Window Rock, Arizona

Project #6537
WELL NO 16T-521

Quad. No. 119 Miles west 10.5 Miles south 10.0

6 miles East of Prewitt, New Mexico
Location

Began well October 15, 1963 Finished well November 13, 1963

Diameter of well 8" Depth of well 414'

Static water level 365' Drawdown 49' Recovery

Quantity of water on test run: bailer: pump: 3 G. P. M. Tested for 3 hours

Kind of casing: 6-5/8" Sizes and length 380' - 414' Perforated

Screen kind Length Mesh

Contractor THE NAVAJO TRIBE Address Window Rock, Arizona
Drillers: G. Williams, Self

LOG

DEPTH From	To	Formation	Acquifer	Remarks
0	40	Alluvium Fill		
40	120	Sandstone		
120	205	Gray Lime - Hard		
205	230	White Lime		
230	260	Gray Lime Hard		
260	280	Sandstone Hard		
280	380	Sandstone Hard		
380	410	White sand soft	Water	
410	414	White lime hard		

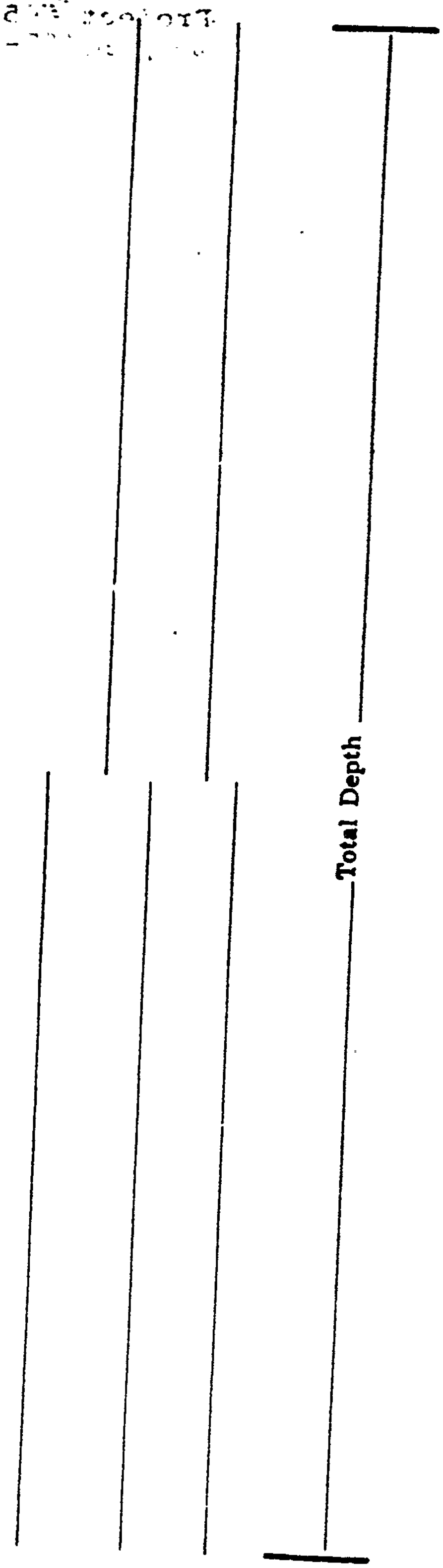
Remarks:
S.P. 750 Temp: 78°

Tera Salts	Calcium Ca	Magnesium Mg	Sodium Na	Chlorides Cl	Sulfates SO_4	Carbonates HCO_3	P.H.	CO_3

Excellent Good Fair Poor Doubtful Not suitable for domestic, livestock use

XXX (under Good)

NTRD - 61



Cylinder size: ______

Tubing, cylinder and suction pipe length in feet: 2" x

Kind of pump rod: ______

Size of box and pin: 3/4" x 7/8"

Liner, if any: ______

Windmill: (make) Aermotor

Size: 16'

Storage: (kind) Galv. & steel

Capacity: 1,000 gal. & 26,000 gal.

Troughs: (kind) No. 2 galv. - 12"x 12"x 12'

Comments: ______

~ 0.119

10.5 x 10.0

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

WELL SCHEDULE

Date 23 December, 1963 Field No. 16T-521

Record by McGavock Office No. ______

Source of data Tribal well record - Observation

1. *Location:* State New Mexico County McKinley
Map 6 ENE of Prewitt
____ ¼ ____ ¼ sec. 18 T 13 N R 10 W

2. *Owner:* TRIBE Address Window Rock
Tenant ______ Address ______
Driller Bill Self - Tribe Address ______

3. *Topography* Gentle slope

4. *Elevation* 7050 E ft. above/below Sl

5. *Type:* Dug, drilled, driven, bored, jetted 11 1963

6. *Depth:* Rept. 414 ft. Meas. ______ ft.

7. *Casing:* Diam. 6⅝ in., to ______ in., Type Screw
Depth 414 ft., Finish Perf. 380-414

8. *Chief Aquifer* Entrada From ______ ft. to ______ ft.
Others ______

9. *Water level* 365 ft. rept. meas. 11-13 1963 above below LS
______ which is ______ ft. above below surface

10. *Pump:* Type ______ Capacity ______ G. M.
Power: Kind ______ Horsepower ______

11. *Yield:* Flow ______ G. M., Pump ______ G. M., Meas., Rept. Est. ______
Drawdown 49 ft. after 3 hours pumping 3 G. M.

12. *Use:* Dom., Stock, PS., RR., Ind., Irr., Obs.
Adequacy, permanence ______

13. *Quality* S.C. 750 Temp 78 °F.
Taste, odor, color ______ Sample Yes No 12-63
Unfit for ______

14. *Remarks:* (Log, Analyses, etc.) Drillers log on well record
Contacts on back
(OVER)

WINDMILL MAINTENANCE RECORD

WELL NO. 16T-521

DATE REPAIRED	WORK DONE AND MATERIALS USED
8/19/69	Run in sucker rods & made new stand pipe. Used 3/4" x 420' sucker rods.
	$1\frac{1}{4}$" gate valve, $1\frac{1}{4}$" x 4" short nipple, 2" x 15' pipe.
8.18.69	Pulled rods
9/12/69	Checked windmill and changed oil.
3/17/70	Checked windmill, ok.
3/19/70	Releathered cups.
09-27-74	CHANGED OIL
10-16-75	Remove Pump jack, but local 11-42's advised not
	till 351 tank is fixed.
10-22-75	Removed the pump jack to station 19

16T-521 Well equipped iwth 16' Aermotor windmill 27,900 gallon storage tank 1,000 gallon Army surplus storage tank elevated where people filled their barrel with drinking water. The big tank is empty.

USGS-WRD
Form QW

16T-521

ANALYTICAL STATEMENT
Ariz. 6.16

COUNTY Mckinley
LAB NO. 53507

119

Location 10.5W x 10.0S
6 miles NE of Prewitt,
N.M.

Source (type of well) Drilled
Owner Navajo Tribe
Window Rock, Ariz.
Date drld Nov. '63 Cased to 414 ft
Depth 414' Diam 6 5/8"
WBF Entrada
Water level 365 ft below surf.
Sampled after pumping ____ hrs
Yield 2 - 3 GPM (meas. or est)
Pt of coll Well
Appearance Reddish
Temp (°F) ____ Use Dom., Stock
Collector Fred Zscach
Chemist EFW
Date completed Feb. 14, 1964
Checked by JON
Date transmitted Mar. 3, 1964

Date of collection Nov. 15, 196_
Ignition Loss ____ Color ____
Dissolved Solids:
Residue at 180°C ____
Calculated (Sum) 581
Tons per Acre Foot 0.79
Hardness as $CaCO_3$ 54
Non-carbonate Hardness 0
% Na 89 SAR 12 pH 7.9
Specific Conductance (micromhos at 25°C) 912

	epm	ppm
SiO_2		10
Fe		
Ca	0.95	19
Mg	0.13	1.6
Na		
K		
Na+K	8.86	204
HCO_3	6.82	416
CO_3	0.00	0
SO_4	2.58	124
Cl	0.42	15
F	0.11	2.0
NO_3	0.01	0.7
	9.94	

Provisional records, subject to revision.

ENTERED NOV 26 1986

TRIBAL WE[illegible]
LOCATIO[illegible]

TRIBAL WELL NO [/6T-522]]]]] PWSID [ ]]]]]]]]]]

WELL NAME/OTHER NO [ ]

WELL TYPE (MARK ONE ONLY)	WELL STATUS (MARK ONE ONLY)	WELL USE (MARK ONE ONLY)
(X)WW WATER WELL	( )ACT ACTIVE	( )DOM DOMESTIC
( )WA ARTESIAN WELL	( )INA INACTIVE	( )AGR AGRICULT.
( )WS SPRING	(X)ABA ABANDONED	(X)LV LIVESTOCK
( )OW OBSERVATION WELL	( ) UNK UNKNOWN	( )IND INDUSTRIAL MINING
( )GS GAS WELL		( )REC RECREATION
( )OP OIL PRODUCTION		( )MUN MUNICIPAL
( )MW MINERAL WELL		( )OTH OTHER
		( ) UNK

QUAD NO [ ]]] MILES WEST [ ]].]]] MILES SOUTH [ ]].]]]

NE SE SW NW/NE SE SW NW/NE SE SW NW [22] [T]/13].0N] [R]/10].0W]
10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE

APPROXIMATE LOCATION [ ]

[ ]]]]]]]]]]] LATITUDE[ ]]]]]]] LONGITUDE[ ]]]]]]]]

UTM COORDINATES: X(east)[782794] Y(north)[3915615] ZONE[12]

OPERATOR[7A/BE 10BW] USGS WATERSHED CODE[ ]]]]]]]]]]]]]

STATE: ( )AZ ARIZONA (X)NM NEW MEXICO ( )UT UTAH ( )CO COLORADO

COUNTY: ( )AP APACHE (X)MK MCKINLEY ( )SJ SAN JUAN ( )MT MONTEZUMA
( )NA NAVAJO ( )VL VALENCIA ( )KA KANE ( )LP LA PLATA
( )CO COCNINO ( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO GRAZING DISTRICT [/6]
( )RA RIO ARRIBA
( )SA SAN JUAN

CHAPTER NAME ______________________________ CHAPTER CODE [BACA]

LOCATION DATA SOURCE: [W]]

LOCATION FILE COMPLETED BY: ______________________ DATE __/__/__

FIELD CHECKED BY: [ ]]]]]]]]]]]]]]]]] DATE __/__/__

rev:840425 form:well record loc

·986 C
·JECT

ENTERED OCT 8 1986

TRIBAL WELL RECORD
LOCATION FILE

TRIBAL WELL NO [16T-551] PWSID [NM0000254]

WELL NAME/OTHER NO [WAYSTACK COMM. SYSTEM WELL]

WELL TYPE (MARK ONE ONLY)	WELL STATUS (MARK ONE ONLY)	WELL USE (MARK ONE ONLY)
(✓)WW WATER WELL	(✓)ACT ACTIVE	( )DOM DOMESTIC
( )WA ARTESIAN WELL	( )INA INACTIVE	( )AGR AGRICULT. LIVESTOCK
( )WS SPRING	( )ABA ABANDONED	( )IND INDUSTRIAL MINING
( )OW OBSERVATION WELL		( )REC RECREATION
( )GS GAS WELL		(✓)MUN MUNICIPAL
( )OP OIL PRODUCTION		( )OTH OTHER
( )MW MINERAL WELL		

QUAD NO [119] MILES WEST [10.65] MILES SOUTH [11.00]

NE SE SW NW/NE SE SW NW/NE SE SW NW [20] [T] RANGE [R]

10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE

APPROXIMATE LOCATION [1 MILE SE OF HAYSTACK MOUNTAIN]

LATITUDE [352045] LONGITUDE [1075529]

UTM COORDINATES: X(east)[ ] Y(north)[ ] ZONE[ ]

OPERATOR [TRIBE] USGS WATERSHED CODE [ ]

STATE: ( )AZ ARIZONA ( )NM NEW MEXICO ( )UT UTAH ( )CO COLORADO

COUNTY: ( )AP APACHE ( )NA NAVAJO ( )CO COCNINO ( )MK MCKINLEY ( )VL VALENCIA ( )BL BERNALLILLO ( )SD SANDOVAL ( )SO SOCORRO ( )RA RIO ARRIBA ( )SA SAN JUAN ( )SJ SAN JUAN ( )KA KANE ( )MT MONTEZUMA ( )LP LA PLATA

GRAZING DISTRICT [16]

CHAPTER NAME BACA CHAPTER CODE [BACA]

LOCATION DATA SOURCE: [TRIBE, B. STONE RT-6]

LOCATION FILE COMPLETED BY: Masud U. Zaman DATE 10/8/1986

FIELD CHECKED BY: [ ] DATE __/__/__

rev:840425 form:well record loc

TRIBAL WELL RECORD
HYDROLOGY FILE

ENTERED OCT 8 1986 JLR

WELL NO [/6 7]-[5 5/]]]]]] USGS AQUIFER CODE [2 3 1] [S N S L]
CHNL

THICKNESS [ ]]]FT NOMINAL YIELD [ ]]]]GPM YIELD MEASURED __/__/__

(X)BAILER (✓)PUMP TEST @ [ ]]5 0]GPM FOR[ ]/6].]0]HOURS DATE 10/7/1976

DRAWDOWN [ ]]]6 7]FT OBSERVATION WELL DATA AVAILABLE ( )YES ( )NO

HORIZ CONDUCTIVITY[ ]]].]]]]FT/DAY SPECIFIC CAPACITY[0].]7 5]GPM/FT After 4 hrs. Pumping.

VERT. CONDUCTIVITY[ ]]].]]]] FT/DAY STORAGE COEF [.]]]]]]]

COEF OF TRANSMISSIVITY [ ]]]]]8 8] FT2/DAY * or 660 GPD/FT.

INDICATE ADDITIONAL PUMPING TEST DATA AVAILABLE AS HARD COPY:
( )Y ( )N MULTIPLE RATE DRAWDOWN PUMPING TEST
(✓)Y ( )N SINGLE RATE DRAWDOWN PUMPING TEST
( )Y ( )N MULTIPLE RATE DRAWDOWN/RECOVERY TEST
(✓)Y ( )N RECOVERY TEST

LOGS AVAILABLE: (✓)DL DRILLER'S LOG ( )EL ELECTRIC LOG

HYDROLOGY DATA SOURCE: [T R I B E]]]]]]]]]]]]]]]]]]]]

HYDROLOGY FILE COMPLETED BY: M.Z. DATE 10/8/1986

STATIC WATER LEVEL FILE

JLR ENTERED OCT 8 1986

DEPTH TO SWL 446 FT DATE 9/17/1969 DEPTH TO SWL ____ FT DATE __/__/__
DEPTH TO SWL 417 FT DATE 10/7/1976 DEPTH TO SWL ____ FT DATE __/__/__
DEPTH TO SWL ____ FT DATE __/__/__ DEPTH TO SWL ____ FT DATE __/__/__
DEPTH TO SWL ____ FT DATE __/__/__ DEPTH TO SWL ____ FT DATE __/__/__
DEPTH TO SWL ____ FT DATE __/__/__ DEPTH TO SWL ____ FT DATE __/__/__
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DEPTH TO SWL ____ FT DATE __/__/__ DEPTH TO SWL ____ FT DATE __/__/__
DEPTH TO SWL ____ FT DATE __/__/__ DEPTH TO SWL ____ FT DATE __/__/__

rev:840427 form: well record hyd

RECEIVED OCT 8 1986

TRIBAL WELL RECO
STRUCTURE FI

WELL NO [161-551] STARTED 9/11/1969 COMPLETED 9/17/1969

ELEVATION [6890] FT DEPTH [1083] FT DEPTH MEASURED 9/17/1969

DEPTH IS (✓)MEASURED ( )ESTIMATED ( )REPORTED WELL DIA. [9.00] IN

1 CASING DIA [7.00] FROM[+2]FT TO[1083]FT MATL[STL]

2 CASING DIA [.] FROM[ ]FT TO[ ]FT MATL[ ]

3 CASING DIA [.] FROM[ ]FT TO[ ]FT MATL[ ]

4 CASING DIA [.] FROM[ ]FT TO[ ]FT MATL[ ]

casing matl codes brs=brass cop=copper evd=everdur irn=iron mon=monel pls=plastic stl=steel sst=stainless steel

1 CASING PERFORATED FROM [833]FT TO[1053]FT OPENING TYPE [P]

2 CASING PERFORATED FROM [ ]FT TO[ ]FT OPENING TYPE [ ]

3 CASING PERFORATED FROM [ ]FT TO[ ]FT OPENING TYPE [ ]

4 CASING PERFORATED FROM [ ]FT TO[ ]FT OPENING TYPE [ ]

5 CASING PERFORATED FROM [ ]FT TO[ ]FT OPENING TYPE [ ]

opening codes: f=fractured rock, l=louvered or shutter-type screen, m=mesh screen, p=perforated,porous,slotted casing, r=wire-wound screen s=screen,type unknown, t=sand point, w=walled or shored, x=open hole z=other

DATE WELL TURNED OVER TO TRIBE: __/__/__

FUNDED BY: [ ] CONTRACTOR: [ ]

SITE IMPROVEMENTS	TYPE OF LIFT	ENERGY SOURCE
( )WM WINDMILL	( )AL AIRLIFT	(✓)EM ELECTRIC MOTOR
( )WP WATERING POINT	( )PS PISTON	( )DE DIESEL ENGINE
(✓)TA TANK	( )TU TURBINE	( )HA HAND
( )WL WATER LINE	( )MT MULTIPLE TURBINE	( )GS GAS ENGINE
( )TR TROUGH		( )LP LP GAS ENGINE
( )CS CISTERN	( )CN CENTRIFUGAL	( )NG NATURAL GAS ENGINE
( )HP HAND PUMP	( )MC MULTIPLE CENTRIFUGAL	( )WM WINDMILL
( )NO NONE		( )SO SOLAR
	( )BU BUCKET	
	⊗⊗ (✓)SU SUBMERSIBLE	

PUMP HP [ ] ON SITE STORAGE CAPACITY [ ] GAL

STRUCTURE DATA SOURCE: [TRIBE]

STRUCTURE FILE COMPLETED BY: M. Z. DATE 10/8/1986

rev:840426 form: well record str

TRIBAL WELL RECORD
COMMENTS FILE

TRIBAL WELL NO 16T-551

PERTINENT
COMMENTS: The Haystack community system serves approximately 140 homes in the area (Dale Cortmel IHS Engineer's letter to Arison Damon Jr. February 5, 1979).

⊗ A bailer test was also run @ 20 GPM for 6 hours. the Drawdown was 41 feet on September 17, 1969.

* T calculated from IHS Pump Test data Time/Drawdown curve on file.

⊗⊗ Originally the well was used as a stock well and used to have a windmill, storage tank, troughs etc. Now well is being used for Haystack Community water supply system since December 20, 1976 and has an electric pump, water tank and a complete control house and the water distribution system.

— Water quality information on file. Water quality is acceptable for Public water supply.

— property easement is on file

ENTERED OCT 09 1986

rev:840430 form: well record com

WELL

Water Well Development
Navajo Tribe
Window Rock, Arizona

WELL NO 16T-551

Quad. No 119 Miles west 10.65 Miles south 11.00

1 mile SE of Haystack Mountain

Location

Began well September 11, 1969 Finished well September 17, 1969

Diameter of well 9.00" Depth of well 1083'

Static water level 446' Drawdown 41' Recovery

Quantity of water on test run: bailer: pump: 21 G. P. M. Tested for 6 hours

Kind of casing: T & C Sizes and length 7" OD x 1085'

PERFORATION: See Attached Sheet

Screen kind Length Mesh

Contractor THE NAVAJO TRIBE Address Window Rock, Az

DRILLERs: B. Yazzie & j. Sam FAILING - 2500 Rotary

LOG

DEPTH From	To	Formation	Acquifer	Remarks
0	55	Top soil brown sand - soft		
55	79	Black Volcanic materials - hard		
79	180	Red shale - soft		
180	190	Red shale and white clay - soft		
190	255	Red shale and purple shale		
255	350	Red shale - soft		
350	376	Red shale and purple sandstone - soft		
376	465	Red shale - soft		
465	470	Red shale and purple and white sandstone - soft		
470	803	Red shale - soft		
803	807	Purple and white sandstone - soft		
807	819	Red and purple shale		
819	822	Purple sandstone		
822	911	Medium grain with to red sandstone - soft		
911	916	White clay - soft		
916	935	Brown to white sandstone - soft		
935	1083	Red brownish sandstone - soft and hard		

Remarks:

S.P.

Teta Salts	Calcium Ca.	Magnesium Mg.	Sodium Na.	Chlorides CL	Sulfates SO_4	Carbonates HCO_3	P.H.	CO_3

Excellent Good Fair Poor Doubtful Not suitable for domestic, livestock use

NTRO - 81

WINDMILL MAINTENANCE RECORD

WELL No.___

DATE REPAIRED	WORK DONE AND MATERIALS USED
10/22/69	Set windmill tower and level.
10/27/69	Replaced 24-21'-0" x 2½ tubing (pipe), 25-21'-0" x 3/4" (pipe) sucker rods, 4-21½" x 1 7/8" leather cups and 2½" cylinder.
12/22/69	Replaced 19-3/4" x 21'-0" sucker rods. 18-2½" x 21'-0" tubing and 2½" x 36" cylinder.
1/12/70	Set up 12' aermotor head and connected pump rod.
2/17/70	Releathered plunger and foot valve.
2/25/70	Installed 4,000 gal storage tank, 1¼" x 2' pipe, 1¼" stop & waste valve, 5-1¼" ell.
3/17/70	Checked windmill, ok.
2-15-72	6 gal. alumuim and 2 gal. alumuim brust.
09-27-74	CHANGED OIL
3/19/75	Checked.

16T-552 Well is equipped with 12' Aermotor, two (2) steel trough, 27,900 gal. storage tank. A new concrete floor needs to be pour for windmill base. It laso needs a tank cover for 27,900 gallon storage tank. The well is being use for domestic use

two steel trough, 6 5/8" casing, 2" tubings, this well has 33,849' of waterline with 7 drinkers. The tank was full when inspected.

WINDMILL MAINTENANCE

16T-551

DATE REPAIRED	WORK DONE AND MATERIALS USED
10/22/69	Used sucker rods, 2½" pipes for corner post, 2" pipe for grit and cross braces out of sucker rods.
11/20/69	Installed 14' aermotor, 2" x 21' pipe, 2-2" close nipples, 2" tee, 2" elbow and 2" short nipple.
1/13/70	Repainted windmill tower.
2/5/70	Installed 4,000 gal storage tank, 1¼" x 2' pipe, 1¼" stop & waste valve, 5-1¼" elbow.
3/17/70	Welded leak on storage tank.
7/17/73	Repaired the 100 DC pump jack motor. Replace 1¼" stop and waste valve.
09-27-74	changed oil
3/19/75 Rent	Replaced stop and waste.
10-22-75	Welded leaky 4,000 gal. tank (Haystack)
16T-551	This well was turned over to the Public Health Service to be use it for 86-121 project, 27,900 gallon storage tank is still existing on this well
7-30-81	METER READING
8-11-81	METER READING
8-14-81	" "
10-2-81	Routine Inspection
10-9-81	" "
10-13-81	~~TE~~ TANK 11½ & METER READING
10-19-81	ROUTINE INSPECTION
10-26-81	INSPECTION
9-4-81	Meter Reading
9-8-81	Tank 10'
9-14-81	Routine Check
9-18-81	Meter Reading
10-2-81	Routine Inspection.
10-9-81	Routine Inspection.
10-13-81	Tank 11½/ Meter Reading
10-19-81	Routine Inspection.
10-26-81	Inspection
07-30-81	Meter Reading
08-11-81	Meter Reading
08-14-81	Meter Reading

T . . . L WELL RECORD
L C .TION FILE

ENTERED OCT 8 1986

TRIBAL WELL NO [1]6]7]-]5]5]2]]]]]]　　PWSID [ ]]]]]]]]]]

WELL NAME/OTHER NO [ ]

WELL TYPE (MARK ONE ONLY)	WELL STATUS (MARK ONE ONLY)	WELL USE (MARK ONE ONLY)
(✓)WW WATER WELL	(✓)ACT ACTIVE	( )DOM DOMESTIC
( )WA ARTESIAN WELL	( )INA INACTIVE	( )AGR AGRICULT.
( )WS SPRING	( )ABA ABANDONED	(✓) LIVESTOCK
( )OW OBSERVATION WELL		( )IND INDUSTRIAL MINING
( )GS GAS WELL		( )REC RECREATION
( )OP OIL PRODUCTION		( )MUN MUNICIPAL
( )MW MINERAL WELL		( )OTH OTHER

QUAD NO [1]1]9]　　MILES WEST [1]2].]6]5]　　MILES SOUTH [ ]9].]9]5]

NE SE SW NW/NE SE SW NW/NE SE SW NW [1]4] [T]1]3].]0]W] [R]1]1].]0]W]
10 acre　40 acre　160 acre　SECT.　TOWNSHIP　RANGE

APPROXIMATE LOCATION [1]]M]I]L]E]]W]E]S]T]]O]F]]H]A]Y]S]T]A]C]K]]]
[M]O]U]N]T]A]I]N]]]　LATITUDE[3]5]2]1]1]3]　LONGITUDE[1]0]7]5]8]2]8]

UTM COORDINATES: X(east)[ ]]]]]]]　Y(north)[ ]]]]]]]]　ZONE[ ]]

OPERATOR[T]R]I]B]E]]]]]]]　USGS WATERSHED CODE[ ]]]]]]]]]]]]

STATE: ( )AZ ARIZONA　(✓)NM NEW MEXICO　( )UT UTAH　( )CO COLORADO

COUNTY: ( )AP APACHE　(✓)MK MCKINLEY　( )SJ SAN JUAN　( )MT MONTEZUMA
( )NA NAVAJO　( )VL VALENCIA　( )KA KANE　( )LP LA PLATA
( )CO COCNINO　( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO　GRAZING DISTRICT [1]6]
( )RA RIO ARRIBA
( )SA SAN JUAN

CHAPTER NAME BACA　CHAPTER CODE [B]A]C]A]

LOCATION DATA SOURCE: [T]R]I]B]E],]E].]S]T]O]N]E]]R]T-]6]]]]]]]]

LOCATION FILE COMPLETED BY: Masud U. Zaman　DATE 10/8/1986

FIELD CHECKED BY: [ ]]]]]]]]]]]]]]]]]　DATE __/__/__

rev:840425　form:well record loc

A L E L RECORD
GY FILE

ENTERED OCT 8

WELL NO [ ]]]]] USGS AQUIFER CODE [2]3]1]]C]H]N]L]

THICKNESS :NAL YIELD [ ]]]]GPM YIELD MEASURED __/__/__

(✓)BAILER [ ]]/]8]GPM FOR[ ]]1].]0]HOURS DATE 10/9/19

DRAWDOWN [OBSERVATION WELL DATA AVAILABLE ( )YES (✓)NO

HORIZ CON .]]]]FT/DAY SPECIFIC CAPACITY[ ].]]]GPM/FT

VERT. CONT .]]]] FT/DAY STORAGE COEF [.]]]]]]]

COEF OF TR]]]]]]]] FT2/DAY

INDICATE A ING TEST DATA AVAILABLE AS HARD COPY:
( )Y ( )N DRAWDOWN PUMPING TEST
( )Y ( )N AWDOWN PUMPING TEST
( )Y ( )N DRAWDOWN/RECOVERY TEST
( )Y ( )N

LOGS AVAIL. ILLER'S LOG ( )EL ELECTRIC LOG

HYDROLOGY [T]R]/]8]8]]]]]]]]]]]]]]]]]]

HYDROLOGY BY:__________ M.Z. DATE 10/8/19

C WATER LEVEL FILE

ENTERED OC

DEPTH TO S ATE 10/9/1969 DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO SW ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

DEPTH TO S ATE__/__/__ DEPTH TO SWL________FT DATE__/__/__

rev:840427 form: well record hyd

TRIBAL WELL RECORD
STRUCTURE FILE

ENTERED OCT 8 1986

WELL NO [1]6]7]-]5]5]2]]]]]] STARTED 9/26/1969 COMPLETED 10/9/1969

ELEVATION [ ]6]6]5]5] FT DEPTH [ ]1]2]6]8] FT DEPTH MEASURED 10/9/1969

DEPTH IS (✓)MEASURED ( )ESTIMATED ( )REPORTED WELL DIA. [ ]9].]0]0] IN

1 CASING DIA [ ]7].]0]0] FROM[ ]]]+]2]FT TO[ ]1]2]6]8]FT MATL[S]T]L]

2 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

3 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

4 CASING DIA [ ]].]]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

casing matl codes brs=brass cop=copper evd=everdur irn=iron mon=monel
pls=plastic stl=steel sst=stainless steel

1 CASING PERFORATED FROM [ ]]9]7]5]FT TO[ ]1]1]3]7]FT OPENING TYPE [P]

2 CASING PERFORATED FROM [ ]1]1]7]0]FT TO[ ]1]2]0]3]FT OPENING TYPE [P]

3 CASING PERFORATED FROM [ ]1]2]3]6]FT TO[ ]1]2]7]0]FT OPENING TYPE [P]

4 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

5 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

opening codes: f=fractured rock, l=louvered or shutter-type screen, m=mesh screen, p=perforated,porous,slotted casing, r=wire-wound screen s=screen,type unknown, t=sand point, w=walled or shored, x=open hole z=other

DATE WELL TURNED OVER TO TRIBE: __/__/__

FUNDED BY: [T]R]I]B]E]]]] CONTRACTOR: [T]R]I]B]E]]]]]]]]]]]

SITE IMPROVEMENTS	TYPE OF LIFT	ENERGY SOURCE
(✓)WM WINDMILL	( )AL AIRLIFT	( )EM ELECTRIC MOTOR
(✓)WP WATERING POINT	(✓)PS PISTON	( )DE DIESEL ENGINE
(✓)TA TANK	( )TU TURBINE	( )HA HAND
(X) (✓)WL WATER LINE	( )MT MULTIPLE TURBINE	( )GS GAS ENGINE
(✓)TR TROUGH 2		( )LP LP GAS ENGINE
( )CS CISTERN	( )CN CENTRIFUGAL	( )NG NATURAL GAS ENGINE
( )HP HAND PUMP	( )MC MULTIPLE CENTRIFUGAL	(✓)WM WINDMILL
( )NO NONE		( )SO SOLAR
	( )BU BUCKET	
	( )SU SUBMERSIBLE	

PUMP HP [ ]]]] ON SITE STORAGE CAPACITY [ ]2]7]9]0]0] GAL

STRUCTURE DATA SOURCE: [ ]

STRUCTURE FILE COMPLETED BY: M.Z. DATE 10/8/1986
rev:840426 form: well record str

TRIBAL WELL RECOR
COMMENTS FILE

TRIBAL WELL NO [1][6][T]-[5][5][2][ ][ ][ ][ ][ ]

PERTINENT
COMMENTS: ⊗ 33,849 feet of water line.

Water quality information on file.

property easement on file ENTERED OCT 9 1986

rev:840430 form: well record com

WELL RECORD

Water Wel...
Navajo Tri...
Window R...

WELL 552

Quad. No. 119 Miles west 12.65 Miles south 9.95

Location: 1 ~~mile~~ West ~~of Haystack~~ Mountain~~;~~ NE, SW, Sec. 14, T13N, R11W N.M.P.M.

Began well September 26, 1969 Finished well October 9, 1969

Diameter of well 9" Depth of well 1268'

Static water level 362' Drawdown None Recovery

Quantity of water on test run: bailer: pump: 18 G. P. M. Tested for 6 hours

Kind of casing: T & C Sizes and length 7" x 1270'

Perforation: See Casing Tally

Screen kind Length Mesh

Contractor THE NAVAJO TRIBE Address Window Rock, Arizona

Driller: Bob Yazzie, Jim Sam

LOG

DEPTH From	To	Formation	Acquifer	Remarks
0	22	Top soil brown to red - soft		
22	30	White sandstone - soft		
30	42	Red sandstone - soft		
42	50	White to red sand & lime streak - Hard		
50	206	Red & blue shale & lime spot - soft		
206	280	Red shale - Soft		
280	715	Red & purple shale - soft		
715	760	Red shale - hard		
760	765	Brown & blue lime stone - very hard		
765	888	Red shale - soft		
888	932	Red shale & lime streak - hard		
932	1000	Fine grained white sandstone, blue & purple shale - soft		
1000	1013	White clay and fine grained white sandstone - soft		
1013	1050	Grey to white sandstone & silt stone - soft		
1050	1080	Blue shale, silty sandstone & grey limestone - hard		
1080	1098	Purple red shale & white sandstone - hard		
1098	1119	Fine grained white sandstone & blue to white clay		
1119	1260	Grey lime stone & fine reddish sandstone - hard		

Remarks:

S.P

Teta Salts	Calcium Ca.	Magnesium Mg.	Sodium Na.	Chlorides CL	Sulfates SO_4	Carbonates HCO_3	P.H.	CO_3

Excellent Good Fair Poor Doubtful Not suitable for domestic, livestock use

NTRO - 61

WELL R[illegible]

Well No. 16T-552

Quad. No. 119 Miles west 12.65 Miles south 9.95

Location: 1 mile West of Haystack Mountain; NE, SW, Sec. 14, T13N, R11W, N.M.P.M.

LOG

DEPTH		FORMATION	REMARKS
FROM	TO		
1260	1268	Purple shale - soft	

REMARKS: Lost circulation 940' to 944'

OPTIONAL FORM
JULY 1973 EDITION
GSA FPMR (41 CFR

UNITED S[illegible]

Mem[illegible]

16-552

TO :	Ejars . Hydrolog[illegible] Water and Sanitation, Navajo Tribe
FROM :	Field Engineer Crownpoint Service Unit
SUBJECT:	Windmill 16T-552

DATE: August 16, 19[illegible]

As per our visit to the Haystack project area, July 13, 1976 and our discussion of the same date concerning the possible use of the subject windmill, please supply this office with any information you have on this well such as total depth, screened depth, static water level, test pumping data and drillers leg.

Preliminary results of the chemical analysis for the subject well follow;

Boron	1.02 mg/l
Fe	0.28 "
Ca	2.00 "
Mg	Trace
Na	190.82 mg/l
K	2.74 mg/l
P	0.0218 mg/l
HCO_3	165.92 mg/l
CO_3	76.80 mg/l
Cl	26.59 mg/l
T	0.89 mg/l
Total F	0.4998 mg/l
EC	850 micromhos/cm
pH	9.1

Based upon this data and the analyses remaining, it appears that test pumping of this well may be feasible.

Your prompt attention to this matter will be appreciated.

s/ Robert Mayers
Robert Mayers,
Field Engineer

RM/ejb

cc: File/chron

16T-552

T 11 W, R 13 N, Section 14, $SW\frac{1}{4}$ of $NW\frac{1}{4}$ N M P M Sept. 22, 1969

A well drilled at this location would start at approximately 6900 feet elevation, and be situated about a mile west of Haystack Mountain. This well will be identical to the well just completed in T 13 N, R 10 W, Section 20, $SW\frac{1}{4}$, 16T-551, with the following exceptions: The new well will not encounter a surface basalt flow and, the new well may begin slightly higher in the section with some Wingate sandstone present.

The quality and quantity of the water will be the same as found in 16T-551.

The anticipated geologic section is as follows:

Formation	Depth (ft.)	Description
Wingate Sandstone	0 - 50	Sandstone, brown to reddish
Chinle Formation Upper Member	50 - 240	Siltstone, limy; pale bluish-gray or olive gray to dark greenish-gray
	240 - 390	Siltstone; reddish brown
Correo Sandstone Member	390 - 465	Sandstone; pale-grayish-red with some gray to pale-brown pebble conglomerate
Middle Member	465 - 865	Siltstone; reddish-brown
Sonsela Sandstone	865 - 1165	Sandstone, conglomerate; white, pale-yellowish-brown, yellow, and brown

W. L. Werrell
Hydrologist

RECEIVED

SEP 2? 1969

W... ER DEVELOPMENT

ABANDONED
Per U.S.G.S Record. ?

TRIBA[illegible] RECORD
LOC[illegible] E

ENTERED OCT 6 1986 [illegible]

TRIBAL WELL NO [1]6]T]-]5]8]6]]]]]]   PWSID [W]M]0]0]0]0]2]5]4]

WELL NAME/OTHER NO [M]A]Y]S]T]A]C]K]]R]U]R]A]L]]W]A]T]E]R]]S]U]P]L]Y] WELL.

WELL TYPE (MARK ONE ONLY)	WELL STATUS (MARK ONE ONLY)	WELL USE (MARK ONE ONLY)
(✓)WW WATER WELL	( )ACT ACTIVE ?	(✓)DOM DOMESTIC
( )WA ARTESIAN WELL	( )INA INACTIVE	(✓)AGR AGRICULT. LIVESTOCK
( )WS SPRING	( )ABA ABANDONED	( )IND INDUSTRIAL MINING
( )OW OBSERVATION WELL		( )REC RECREATION
( )GS GAS WELL		( )MUN MUNICIPAL
( )OP OIL PRODUCTION		( )OTH OTHER
( )MW MINERAL WELL		

QUAD NO [1]1]9]   MILES WEST [1]0].]4]5]   MILES SOUTH [ ]9].]8]0]

NE SE SW NW/NE SE SW NW/NE SE SW NW   [1]8]   [T]1]3].]0]N]   [R]1]0].]0]W]
10 acre   40 acre   160 acre   SECT.   TOWNSHIP   RANGE

APPROXIMATE LOCATION [N]E]A]R]]M]A]Y]S]T]A]C]K]]M]O]U]N]T]A]I]N]]]]

[ ]]]]]]]]]]]]   LATITUDE[3]5]2]1]4]3]   LONGITUDE[1]0]7]5]6]0]2]

UTM COORDINATES: X(east)[ ]]]]]]]   Y(north)[ ]]]]]]]]   ZONE[ ]]

? OPERATOR[T]R]I]B]E]]O]&]M]   USGS WATERSHED CODE[ ]]]]]]]]]]]]

STATE: ( )AZ ARIZONA   (✓)NM NEW MEXICO   ( )UT UTAH   ( )CO COLORADO

COUNTY: ( )AP APACHE   (✓)MK MCKINLEY   ( )SJ SAN JUAN   ( )MT MONTEZUMA
( )NA NAVAJO   ( )VL VALENCIA   ( )KA KANE   ( )LP LA PLATA
( )CO COCNINO   ( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO   GRAZING DISTRICT [1]6]
( )RA RIO ARRIBA
( )SA SAN JUAN

CHAPTER NAME BACA   CHAPTER CODE [B]A]C]A]

LOCATION DATA SOURCE: [T]R]I]B]E],]I]H]S],]B].]S]T]O]N]E]]R]T]-]6]]]

LOCATION FILE COMPLETED BY: Masud U. Zaman   DATE 10/3/1986

FIELD CHECKED BY: [ ]]]]]]]]]]]]]]]]   DATE __/__/__

rev:840425   form:well record loc

ENTERED OCT 6 1986 JWR

T

TRIBAL WELL RECORD
HYDROLOGY FILE

See Remarks

WELL NO [1]6]7]-[5]8]6]]]]]] USGS AQUIFER CODE [ ]]]]]]]]

THICKNESS [ ]]]FT NOMINAL YIELD [ ]]]]GPM YIELD MEASURED __/__/__

( )BAILER ( )PUMP TEST @ [ ]]9]0]GPM FOR[ ]2]4].]0]HOURS DATE __/__/__

DRAWDOWN [ ]]]9]9]FT OBSERVATION WELL DATA AVAILABLE ( )YES (✓)NO

HORIZ CONDUCTIVITY[ ]]].]]]]FT/DAY SPECIFIC CAPACITY[ ].]]]GPM/FT

VERT. CONDUCTIVITY[ ]]].]]]] FT/DAY STORAGE COEF [.]]]]]]]

COEF OF TRANSMISSIVITY [ ]]]]]]]] FT2/DAY

INDICATE ADDITIONAL PUMPING TEST DATA AVAILABLE AS HARD COPY:
( )Y ( )N MULTIPLE RATE DRAWDOWN PUMPING TEST
( )Y ( )N SINGLE RATE DRAWDOWN PUMPING TEST
( )Y ( )N MULTIPLE RATE DRAWDOWN/RECOVERY TEST
( )Y ( )N RECOVERY TEST

LOGS AVAILABLE: (✓)DL DRILLER'S LOG (✓)EL ELECTRIC LOG

HYDROLOGY DATA SOURCE: [I]MS]]

HYDROLOGY FILE COMPLETED BY: M. Z. DATE 10/3/1986

ENTERED OCT 6 1986 JWR

STATIC WATER LEVEL FILE

⊗ DEPTH TO SWL 47 FT	DATE 6/16/1976	DEPTH TO SWL ____ FT	DATE __/__/__
⊗ ⊗ DEPTH TO SWL 580 FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__
DEPTH TO SWL ____ FT	DATE __/__/__	DEPTH TO SWL ____ FT	DATE __/__/__

rev:840427 form: well record hyd

ENTERED

TRIBAL WELL RECORD
STRUCTURE FILE

WELL [ ] [ ] [ ] [ ] [ ] [ ] [ ] STARTED 10/30/1975 COMPLETED

ELEVATION [ ] [ ] [ ] [ ] [ ] FT DEPTH [ ]2]4]0]0] FT DEPTH MEASURED 6/18/1976

DEPTH IS (✓)MEASURED ( )ESTIMATED ( )REPORTED WELL DIA. [1]0].[6]2] IN

1 CASING DIA [ ]8].[6]2] FROM[ ]]]0]0]FT TO[ ]1]5]5]5]FT MATL[S]T]L]

2 CASING DIA [ ]].[ ]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

3 CASING DIA [ ]].[ ]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

4 CASING DIA [ ]].[ ]] FROM[ ]]]]]FT TO[ ]]]]]FT MATL[ ]]]

casing matl codes brs=brass cop=copper evd=everdur irn=iron mon=monel pls=plastic stl=steel sst=stainless steel

Perforation against chinle formation

1 CASING PERFORATED FROM [ ]1]4]0]0]FT TO[ ]1]4]2]1]FT OPENING TYPE [P]

2 CASING PERFORATED FROM [ ]1]4]3]2]FT TO[ ]1]4]9]5]FT OPENING TYPE [P]

3 CASING PERFORATED FROM [ ]1]5]0]5]FT TO[ ]1]5]5]6]FT OPENING TYPE [P]

4 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

5 CASING PERFORATED FROM [ ]]]]]FT TO[ ]]]]]FT OPENING TYPE [ ]

opening codes: f=fractured rock, l=louvered or shutter-type screen, m=mesh screen, p=perforated,porous,slotted casing, r=wire-wound screen s=screen,type unknown, t=sand point, w=walled or shored, x=open hole z=other

DATE WELL TURNED OVER TO TRIBE: __/__/__

FUNDED BY: [I]H]S]]]]]] CONTRACTOR: [T]R]I]B]E]]]]]]]]]]

SITE IMPROVEMENTS	TYPE OF LIFT	ENERGY SOURCE
( )WM WINDMILL	( )AL AIRLIFT	( )EM ELECTRIC MOTOR
( )WP WATERING POINT	( )PS PISTON	( )DE DIESEL ENGINE
( )TA TANK	( )TU TURBINE	( )HA HAND
( )WL WATER LINE	( )MT MULTIPLE TURBINE	( )GS GAS ENGINE
( )TR TROUGH		( )LP LP GAS ENGINE
( )CS CISTERN	( )CN CENTRIFUGAL	( )NG NATURAL GAS ENGINE
( )HP HAND PUMP	( )MC MULTIPLE CENTRIFUGAL	( )WM WINDMILL
( )NO NONE		( )SO SOLAR
	( )BU BUCKET	
	( )SU SUBMERSIBLE	

PUMP HP [ ]]]] ON SITE STORAGE CAPACITY [ ]]]]]]] GAL

STRUCTURE DATA SOURCE: [T]R]I]B]E]]]]]]]]]]]]]]]]]]]]

STRUCTURE FILE COMPLETED BY: ______________ M.Z. DATE 10/3/1986

rev:840426

form: well record str

L WELL RECORD
OG FILE

TRIBAL WELL NO [1][6][T]-[5][8][6][ ][ ][ ][ ][ ] DATE LOGGED [1][2]/[0][4]/[ ][ ]

WELL NAME/OTHER NO [ ]

TYPE OF LOG [G][A][M][M][A][ ][R][A][Y][,][ ][S][P][,][R][E][S][I][S][T][I][V][I][T][Y][ ][ ][ ][ ]

NE/SE SW NW/NE SE SW NW/NE SE SW NW [1][8] [T][1][3].[0][W] [R][1][0].[0][W]
10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE

FT-E/W [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] FT-N/S [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

UTM COORDINATES: X(east)[ ][ ][ ][ ][ ][ ][ ] Y(north)[ ][ ][ ][ ][ ][ ][ ][ ] ZONE[ ][ ]

STATE: ( )AZ ARIZONA (✓)NM NEW MEXICO ( )UT UTAH ( )CO COLORADO

COUNTY: ( )AP APACHE (✓)MK MCKINLEY ( )SJ SAN JUAN ( )MT MONTEZUMA
( )NA NAVAJO ( )VL VALENCIA ( )KA KANE ( )LP LA PLATA
( )CO COCNINO ( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO DEPTH OF HOLE [ ][2][4][0][0] FT
( )RA RIO ARRIBA HOLE LOGGED 1680 FT
( )SA SAN JUAN BIT SIZE/DIA. [1][0].[6][2] IN

LOG FILE COMPLETED BY: M.Z. DATE 10/6/1986
****

TRIBAL WELL NO [1][6][T]-[5][8][6][ ][ ][ ][ ][ ] DATE LOGGED [1][2]/[0][4]/[7][5]

WELL NAME/OTHER NO [ ]

TYPE OF LOG [C][A][L][I][P][E][R][ ]

NE/SE SW NW/NE SE SW NW/NE SE SW NW [1][8] [T][1][3].[0][W] [R][1][0].[0][W]
10 acre 40 acre 160 acre SECT. TOWNSHIP RANGE

FT-E/W [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] FT-N/S [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

UTM COORDINATES: X(east)[ ][ ][ ][ ][ ][ ][ ] Y(north)[ ][ ][ ][ ][ ][ ][ ][ ] ZONE[ ][ ]

STATE: ( )AZ ARIZONA (✓)NM NEW MEXICO ( )UT UTAH ( )CO COLORADO

COUNTY: ( )AP APACHE (✓)MK MCKINLEY ( )SJ SAN JUAN ( )MT MONTEZUMA
( )NA NAVAJO ( )VL VALENCIA ( )KA KANE ( )LP LA PLATA
( )CO COCNINO ( )BL BERNALLILLO
( )SD SANDOVAL
( )SO SOCORRO DEPTH OF HOLE [ ][2][4][0][0] FT
( )RA RIO ARRIBA HOLE LOGGED 1680 FT
( )SA SAN JUAN BIT SIZE/DIA. [1][0].[6][2] IN

LOG FILE COMPLETED BY: M.Z. DATE 10/6/1986

rev:840820 form:well record log

TRIBAL WELL RECORD
COMMENTS FILE

TRIBAL WELL NO 16T-586

PERTINENT
COMMENTS: * Originally well drilled to 733 feet depth, logged and bailed. Specific Conductance 200 mmhos on 10-30-1975
Well deepened to 2,400 feet through Repe into Psa, Pg and tested
Specific Conductance 20420 on 6-18-1976.
Perforated opposite Reps and retested, Sp. Cond. 33810 mmhos
on 12-22-76, Abandoned.

(x) Static water level 47 feet when well tapped Pg, Psa at
2400 feet depth.

(x)(x) S.W.L 580 feet when well perforated against Chinle Formation.

1. U.S.G.S well Feasibility Report written for IHS is on file.
2. As built drawing upto 1686 feet with well completion
to 1550 feet depth on file. ENTERED OCT 7 1986

rev:840430 form: well record com

WELL RECORD

lopment
Navajo Tribe
izona

16T-586

Quad. No. 119 (S.W.) ¼ Miles west 10.45 Miles south 9.80

NW¼, NE¼, Section 18,T13 N R 10W, Haystack, New Mexico
Location

Began well ______ Finished well January 05, 1976

Diameter of well 10-5/8 inch Depth of well 1555 feet ?

Static water level 580 feet Drawdown none Recovery none

Quantity of water on test run: bailer: pump: 8.5 G. P. M. Tested for 12 hours

Kind of casing: T/C Sizes and length 8-5/8 inch O.D. X 1555 feet

Screen kind Machine slotted Length 1400 feet - 1421.57 feet
1431.57 feet - 1495 feet Mesh
1505 feet - 1555 feet

Contractor The Navajo Tribe Address Water and Sanitation Division
Drillers: Jerry Barney
Steven Yazzie
Post Office Box 678
Fort Defiance, Arizona

LOG

DEPTH From	To	Formation	Acquifer	Remarks
0'	70'	Surface Soil - Fine sand		Soft
70'	110'	Red and White sandstone with yellow gravels		Soft
110'	120'	Red and white sandstone		Soft
120'	140'	Red, white and gray sandstone		Soft
140'	150'	Red sandstone		Soft
150'	250'	Pink to white sandstone		Soft
250'	260'	Gray and light red sandstone		Soft
260'	280'	Lime stone		Hard
280'	290'	White and red sandstone		Soft
290'	455'	Orange sandstone		Soft
455'	480'	Orange and white sandstone		Soft
480'	550'	Orange sandstone		Soft
550'	560'	Orange shale		Soft
560'	938'	Orange white and brown shale with sandstonee		Soft
938'	1214'	Red and blue sandstone		Hard
1214'	1375'	Clay		Hard
1375'	1420'	Red, brown and purple shale with white sandstone		Hard

Remarks: Surface casing: 12½ inch to 200 feet

S.P.

Teta Salts	Calcium Ca.	Magnesium Mg.	Sodium Na.	Chlorides CL	Sulfates SO_4	Carbonates HCO_3	P.H.	CO_3

Excellent Good Fair Poor Doubtful Not suitable for domestic, livestock use

* The hole was drilled up to 1718 feet.. The hole caved in up to 1686 cement plug was set from 1686 to 1555.

NTRD-61

WELL RECORD

Ground Water Development
The Navajo Tribe
Window Rock, Arizona

WELL NO. 16T-586

Quad. No. 19 (SW¼) Miles west 10.45 Miles south 9.80

Location: NW¼, NE¼, Section 18.T13 N R 10W, Haystack, New Mexico

LOG

DEPTH		FORMATION	REMARKS
From	To		
1420'	1489'	Red shale with white and gray sandstone	Hard
1489'	1555'	Red shale	Soft
1555'	1718'	Purple, light blue and red shale	Hard

REMARKS:

NAVAJO SUPERFUND PROGRAM

BROWN VANDEVER SI REPORT

Reference 14

P. ANTONIO MARCH'92

HYDROLOGY OF AREA 62, NORTHERN GREAT PLAINS AND ROCKY MOUNTAIN COAL PROVINCES, NEW MEXICO AND ARIZONA

BY
F. E. ROYBAL, J. G. WELLS, R. L. GOLD, AND J. V. FLAGER

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS
OPEN-FILE REPORT 83-698

ALBUQUERQUE, NEW MEXICO
APRIL, 1984

Light-Colored Low Humus Soils Predominant

Soils vary with landscape and are different on flood plains, hillslopes, and mountain slopes.

The soils of Area 62 are separated into 18 map units as described in figure 2.4-1. These map units have been grouped into three broad categories classified largely with respect to climate, to topographic setting, and to soil colors. The color of soil generally relates to the amount of humus present with dark-colored soils containing more humus than light-colored soils. The three categories are described below.

The "light colored soils of the cool plateau region" (map units 1 to 8) (fig. 2.4-2) are dominated by Torriorthents and Haplargids groups. These soils are dry and (or) salty. The soils principally are derived from sandstone, shale, and limestone. Soils of this category mainly are present on gently sloping and undulating landscapes, but also on steeply sloping and rolling ridges. The texture of this soil category ranges from sandy loam to heavy clay loam.

The "moderately dark colored soils of the cool plateau region" (map units 9 to 12) are dominated by Argiustolls and Rockland groups. Soils are primarily derived from volcanic rock and limestone. Soils of this category are on steeply sloping mesa tops and steep to very steep slopes and escarpments. These soils generally have surface layers of stony loam, clay loam, and fine sandy loam.

The "moderately dark and dark colored soils of the cool to cold mountain region" (map units 13 to 18) are dominated by the Eutroboralfs group. Soils are weathered from sandstone, shale, limestone, and basalt. Generally, soils are deep on nearly level valley areas. Soils are shallow on steep to very steep mountain slopes. The soil texture ranges from loam to clay. The soils in this category are located within the zones of greatest precipitation and highest altitude of Area 62.

More detailed information on the soil types described in this report are available from reports by Maker and others (1972, 1974, 1978). For the soils scientist involved in planning for reclamation of mined land, the report by the U.S. Department of Agriculture (1979) might also be useful.

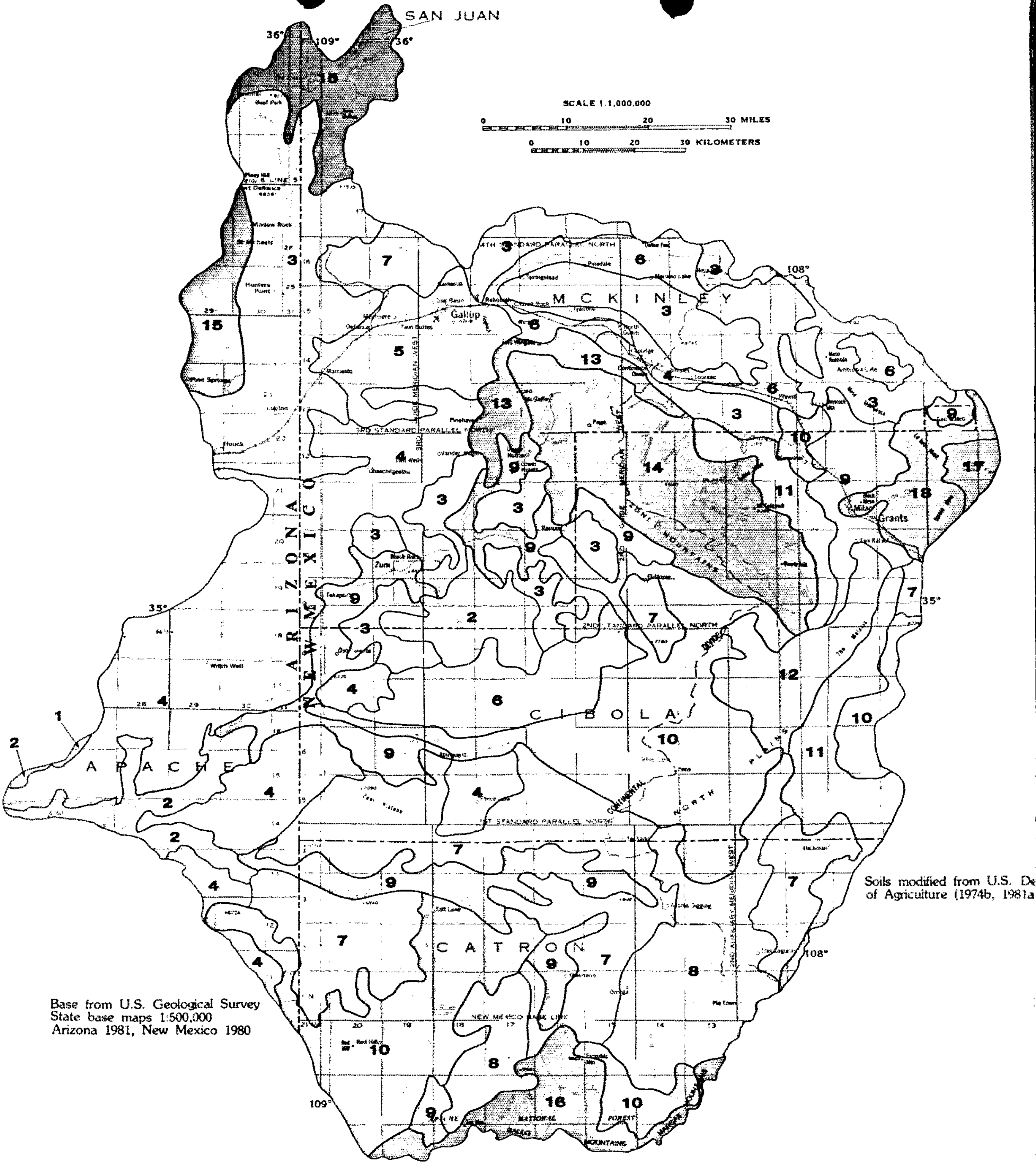

Figure 2.4-1 General soil map.

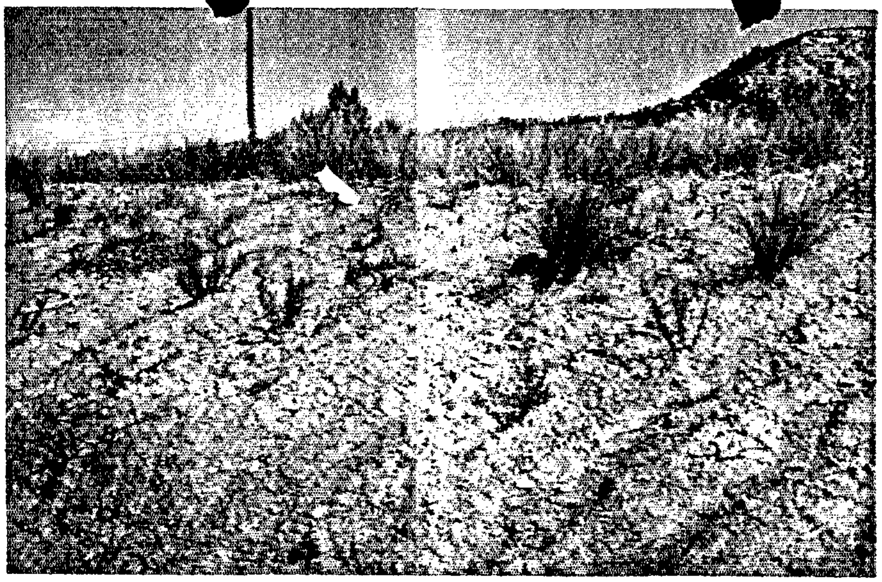

Figure 2.4-2 Light-colored soils (south of Gallup, New Mexico).

EXPLANATION

(>,greater than)

Map Symbol	Map unit	Topographic setting	Soil depth (inches)	Slope (percent)	Altitude above sea level (feet)
	LIGHT COLORED SOILS OF THE COOL PLATEAU REGION				
1	Badland-Torriorthents-Torrifluvents	Hillslopes, ridges, flood plain	0-60	0-60	5,500 to 6,000
2	Torrifluvents	Flood plain, alluvial fans	>60	0-2	5,500 to 7,000
3	Rock outcrop-Torriorthents-Haplargids	Canyon walls, hillslopes, plains	0-40	1-70	5,800 to 7,500
4	Haplargids-Torripsamments-Torrifluvents	Plains, stabilized dunes	>60	0-8	5,500 to 7,500
5	Torriorthents-Rock outcrop	Hillslopes, escarpments	0-20	3-60	6,200 to 6,800
6	Camborthids-Torriorthents	Plains, hillslopes	6-40	1-12	6,400 to 7,000
7	Haplargids-Torriorthents-Rock outcrop	Plains, hillslopes, canyon walls	0-40	1-60	6,200 to 7,000
8	Haplargids	Plains	15-60	1-20	6,400 to 7,900
	MODERATELY DARK COLORED SOILS OF THE COOL PLATEAU REGION				
9	Torrifluvents-Haplargids-Haplustolls	Flood plain, plains, valley floors	>60	0-3	6,200 to 7,400
10	Argiustolls-Haplustalfs-Rock outcrop	Plains, hillslopes, escarpments	0-40	0-30	7,100 to 7,800
11	Rockland-Torriorthents-Argiustolls	Hillslopes, escarpments	0-20	2-75	7,000 to 7,500
12	Lava rockland	Rock, broken land surface	–	2-10	7,000 to 7,500
	MODERATELY DARK AND DARK COLORED SOILS OF THE COOL TO COLD MOUNTAIN REGION				
13	Rock outcrop-Haplustolls-Argiustolls	Canyon walls, hillslopes	0-20	5-70	6,000 to 7,500
14	Eutroboralfs-Argiborolls	Mountain slopes	10-40	5-40	7,500 to 8,500
15	Eutroboralfs-Ustorthents	Mountain slopes	10-50	2-40	7,000 to 9,000
16	Argiborolls-Cryoborolls-Ustorthents	Mountain slopes	15-60	2-40	7,000 to 9,800
17	Cryoboralfs-Paleboralfs-Eutroboralfs	Mountain slopes	20-60	10-75	8,500 to 11,300
18	Argiustolls-Rockland	Basalt-capped mesas, lava flows, volcanic hills, escarpments	0-40	0-75	7,000 to 8,500